The Petroleum Engineer

ALL DIVISIONS
• Exploration Drilling and Production
• Oil and Gas Pipelining
• Refining and Gas Processing

MARCH, 1950 • VOLUME XXII • NUMBER 3

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Depletion Allowance Is National Safeguard

It is estimated that the total tax bill of the oil industry in 1949 was more than three billion dollars. As though this were not enough, the administration in Washington is now exerting pressure on Congress for more taxes on oil. This it is doing by attacking the tax depletion allowance and requesting its reduction from 27½ per cent to 15 per cent. Considering the fact that our whole national economy is geared to forestalling and preparing for the possibility of sudden war, and that oil is so vital a sinew, assailing the depletion allowance in the present circumstances is difficult to understand. A cut in depletion allowance would be a severe blow to the domestic producing industry and drastically curtail its operations.

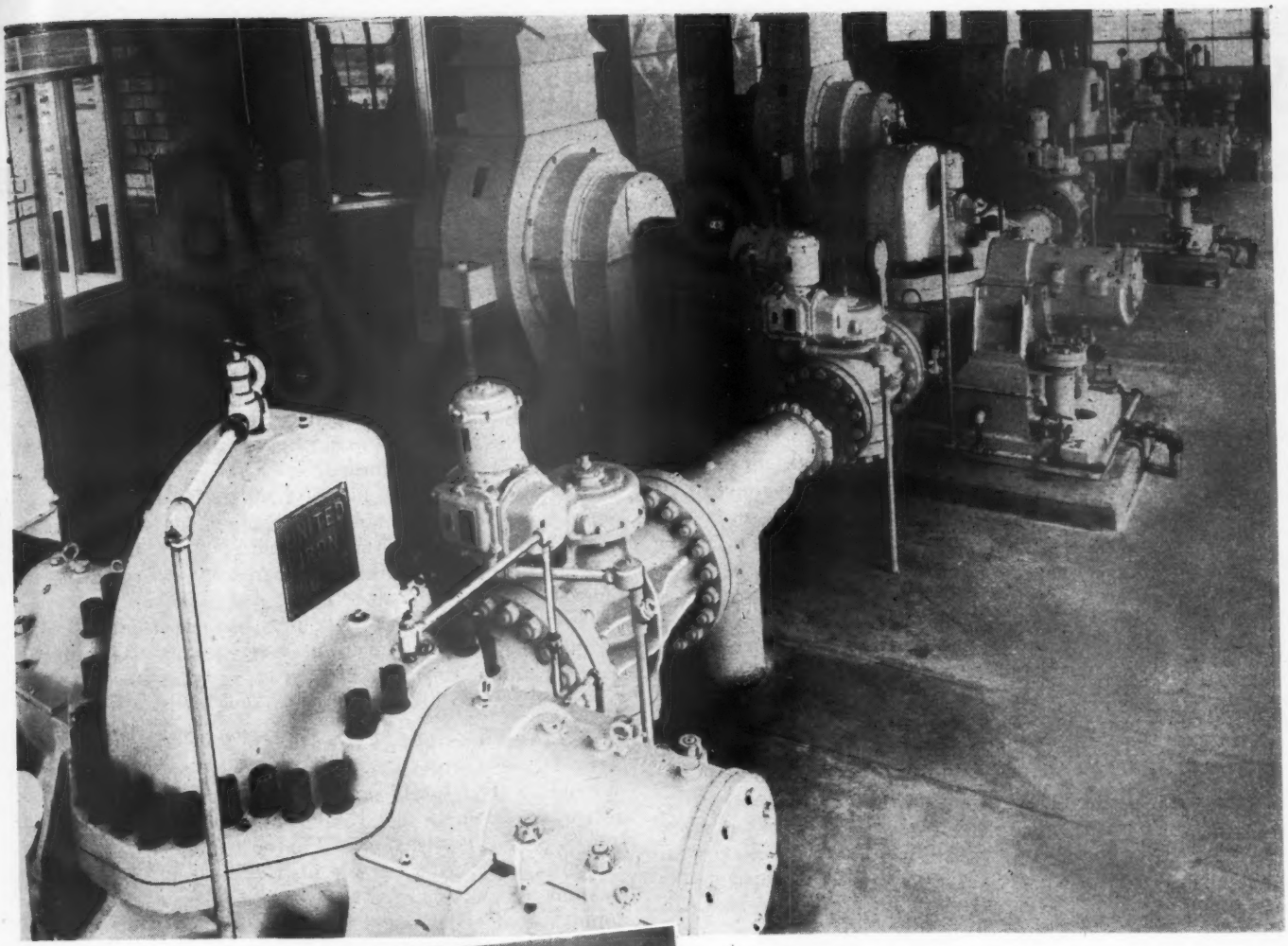
There is overwhelming substantiating evidence in the industry's operations to show the necessity for maintaining the depletion tax allowance. The trend in cost of finding new oil reserves is sharply upward because of the increasingly greater average depth of new discoveries. Of more than 80 wildcat wells drilled in 1949 to depths greater than 12,000 feet, only 7 found new fields at these depths. These 7 wells, ranging in depth from 12,000 feet to more than 14,900 feet, cost from $350,000 to more than $600,000 per well. It is an incontrovertible fact that the average depth of future oil discoveries must inevitably increase and the cost of development rise accordingly.

The depletion allowance is the means of returning capital on a wasting asset. When it was established more than twenty-five years ago, its purpose—an important consideration at that time—was to assure an adequate supply of oil in the United States. If the necessity for a depletion allowance of 27½ per cent was important then, it is doubly important now when oil is so vital in the national interest.

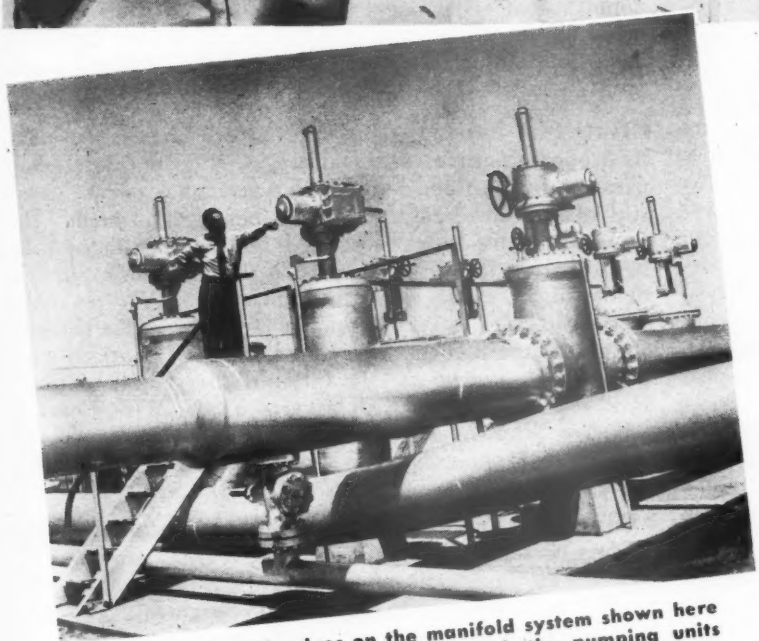
The industry has done a magnificent job in supplying oil for two World Wars. It supplied the bulk of oil needs in World War II even under the handicap of critical material shortages. This it was able to do because of the ability to increase the rate of production from fields already developed. By the time hostilities ceased several fields were producing beyond their maximum efficient rate. The ready availability of an abundant supply of oil in the present unsettled conditions are more imperative than ever in the light of our own national security, a consideration that is either overlooked or neglected by those administration officials pressing for a reduction in depletion allowance.

Although the threat of a reduction in the depletion allowance is one of immediate concern to the oil industry of the United States, more important is that a cut in depletion allowance could undermine our ability to maintain an adequate domestic supply of readily available oil for national emergency.

If from no other consideration than that of national security, tampering with the depletion tax allowance on oil is dangerous under present world conditions. A cut in depletion allowance could cripple our domestic oil industry and render the nation vulnerable in case of war. Can we afford to take that risk?—K. C. S.



Interior view of a new and modern pipe line pump station showing three 1250 hp and one 500 hp, 1800 rpm, 4000 volt motors, direct connected to centrifugal pumps. This combination of motors and pumps provides great flexibility for varying throughput.



Motor operated valves on the manifold system shown here add greatly to the speed with which the pumping units may be put on the line or taken out of service. All motors are controlled from a central control board of the console type, simply by pushing buttons.

High Efficiency-- Low Power Cost

The use of utility electric service in this modern pipe line has made it possible for this line to be operated at a maximum efficiency at the lowest power cost. Modern automatic controls, together with safety and protective devices effect a great saving in manpower. Low original investment, with correspondingly less fixed charges, low maintenance, and high salvage value are advantages that users of utility electric service in pipe line operation can expect.

TEXAS ELECTRIC SERVICE COMPANY

Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Controversial issues involving oil, gas, and coal—and the competition among these fuels—are pressing on the White House for decision, so persistently that President Truman may soon appoint a fact-finding commission to study the whole situation and make recommendations for a national policy on all fuels, as the Baruch committee did on rubber in 1942.

The idea would be to select a group of prominent citizens, hire a large technical staff and make a complete study of all angles of the oil, coal, and gas industries, similar to the governmental reorganization committee headed by former President Hoover.

The coal crisis sharpened up the whole fuels picture. But it is a broader problem than one fuel, or the competition among all fuels. Ultimately, it becomes a question of what is best for the general economy and for national security.

Oil Issues Pending. Many oil questions have been laid on the White House doorstep for answer. Others are on their way there because only the President can decide them. These issues include what to do about the oil import problem, the British moves to oust American-owned oil from world markets, the incentives for continuance of oil exploration, the need for providing a market for displaced dollar oil abroad, the development of synthetic fuels, the Mexican oil loan, and the tidelands oil development.

Imports. If President Truman does decide to set up a fuels commission, one of its certain assignments will be to recommend a national oil policy, including a permanent solution of the imports problem. With this in prospect, it is unlikely that Truman will do more now than perhaps a "quickie" approach. For example, he might call an industry-wide conference to see if some sort of temporary program could be worked out for voluntary cutbacks in import schedules.

The "token cutbacks" in import schedules announced by the larger importers, plus the 150,000 bbl a day reduction in Venezuelan production, has tended to ease the pressure on the White House for action.

The time for the independent producers to have struck was late in January when the National Petroleum Council's import report—endorsed by most of the importing companies—made an explicit finding that the domestic industry had been "hurt" by imports.

At that time, also, President Truman was steamed up to do something about imports, according to federal officials, members of Congress, and state officials who had talked with him.

Now, it seems likely that Truman will want to take a long look at the whole picture before deciding on a permanent policy regarding imports.

A further indication that no final answer on imports is in sight was the scheduling of more field hearings, beginning in mid-April, by Congressman Keogh (D, New York) to collect evidence on how imported oil is affecting the domestic industry. Itinerary probably will include Mississippi, Louisiana, Arkansas, Oklahoma, Montana (and perhaps Wyoming), and California. Last year, hearings were held in Wichita and Dallas.

Depletion. The all-out defense of the oil-gas depletion allowance has taken up time and energies of the independent producers that might have been devoted to pressing for action on imports. And the depletion situation is still serious, despite optimistic rumors going around. No one can be sure, at this time, what will be done on the House side. And then there is the Senate. It is still an uphill fight to preserve the 27½% allowance unchanged even though oil-state representatives and oil men made out a good case before the Ways and Means Committee.

It is going to be difficult for Congress to repeal the war-time excise taxes and make up the revenue loss by closing "loopholes" without doing something about the depletion allowance, which President Truman seems to regard as the biggest "loophole" of all.

This may be the reason behind the persistent talk of a compromise on the depletion issue, perhaps a graduated scale dropping downward as gross income increases and giving more favorable treatment to new wells.

Oil Investigations. The seeds are being planted for further oil investigations, with Senator Wherry (R, Nebraska) succeeding in re-establishing a special small business committee in the Senate such as he headed in the 80th Congress. It will be recalled that the Wherry Committee's report in January, 1949, attacked oil proration as a "price-fixing" instrument, and charged that the oil industry was a "monopoly" and recommended steps to halt "concentration" including divorcement of pipelines, tankers, and marketing operations. Membership on the new committee will be mostly the same as when it was headed by Wherry.

Antitrust Suits. Department of Justice has boiled down its proposed antitrust complaint against California oil companies "to less than a hundred typewritten pages—but it still needs considerable polishing before it is filed." This impending suit, which is based largely on testimony taken last year by a federal grand jury, is likely to cover almost as many angles as the API suit pending here for ten years. This 1940 suit has become known as "the Mother Hubbard Case" because it covers everything. So, the Los Angeles suit may become known as "the Little Mother Hubbard Case". It is expected to cover all aspects of the West Coast oil industry, from retail pricing all the way back to the well, including the voluntary conservation program. After it is filed, the 1940 case probably will be dismissed.

Oil Policy. Congressman Harris (D, Arkansas), chairman of the petroleum subcommittee of the House Commerce Committee—the senior oil committee in Congress, dating back to 1934—plans to go ahead with his hearings to develop a national oil policy. However, there are signs that various government agencies are trying to steal the ball away. Federal Trade Commission, for example, has become very active on oil. And there is a bill pending before Harris' own committee that would authorize the FTC to investigate petroleum to provide Congress with a basis for legislating an oil policy. It is understood that the Missouri Farm Association, a co-op with its own refinery, is behind this bill, which was introduced by Congressman Cannon (D, Missouri). FTC has had a blueprint ready for a comprehensive oil investigation—but lacked the funds. Mr. Cannon, as chairman of the House Appropriations Committee, is in a position to remedy this situation.

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Highlights in Oildom

Predicts Domestic Output Increase. The Interior Department's gas and oil director, Hugh A. Stewart, has advised Congress against curbing petroleum imports, and added, much to the chagrin of the independent producer, that he believed independent producers are "more scared than hurt." Immediately afterward, as if applying soothing balm to wounded feelings, E. B. Swanson, assistant director, predicted a decline in oil imports and an increase in domestic production. In commenting on the combination of increased imports and cutbacks in domestic production, Swanson said, "we're about to change in the opposite direction." He added that demand for oil is running above last year's and stores of oil above ground have decreased.

Oil Money Is Going for Agriculture. The fabulous oil tycoon, H. L. Hunt, is reported by *The Dallas Morning News* to be considering a gigantic soil conservation program in Kaufman County, Texas. Hunt, who owns 16 farms in Kaufman County, is using farm managers to get his soil-building program under way, but Kaufman County residents say his final goal is to see "independent, hard-working people back on these farmlands."

Britain Restricts Imports of Dollar Oil. American companies will lose about one-third of their market in the sterling area, as a result of Britain's oil restrictions against American companies. Government officials have reported they were informed that all exports of dollar fuel oil to the United Kingdom are barred and gasoline shipments from American companies must be reduced 30 per cent. Standard Oil Company (New Jersey), which has been supplying much of British fuel oil requirements through subsidiaries, is the most heavily hit by the ban. Oil executives had hoped the British would delay putting the new controls into effect, and some discussion had taken place on possible ways to soften the new rule.

Price-war Lowers Gasoline Prices. Price-cutting in the retail gasoline market seems to be sweeping the nation. Lower prices have been reported in the area west of the Mississippi river and are invading the Appalachian area. Cuts range from 2 to 5½ cents a gallon on the West Coast, and in the Indianapolis metropolitan area. Average cuts over the nation range 1 to 2 cents a gallon.

Sweden May Have First Oil Well. What began as a water well may very well turn out to be Sweden's first oil well, reports the *Gothenburg Trade and Shipping Journal.* A 300-ft well that was being dug for water at Loederup in Scania province suddenly produced oil. Dr. Johann Hede of Lund University's geological department is quoted as saying this is the most important indication to date of oil in Sweden.

Federal Government Claims Texas Ports, Harbors. According to a claim contained in the federal government's brief in the tideland's case, the government is claiming all Texas ports and harbors as well as the tidelands. Price Daniel, attorney general of Texas, made the announcement before the Texas legislature, after which a message to Congress was approved urging passage of pending laws giving states full ownership of the tidelands—potentially rich in oil. Daniel said the claim to Texas ports and harbors, if actually pressed like the tidelands claim, would cloud the title of properties of far greater value than the tidelands.

Four Problems Face Oil Industry, McCollum Says. The oil industry today is facing four serious problems, L. F. McCollum, president of Continental Oil Company, told members of the seventh district of the Texas Bankers association in Fort Worth, Texas. Conservation, balancing of supply and demand, adjustment of imports, and unwarranted tax penalization are all problems the industry must face, McCollum stated. He pointed out that the oil industry is aided by conservation practices, hampered by increased imports, and further harrassed by the threat of government penalization of the oil industry—elimination of, or sharp reduction of depletion allowance on tax returns.

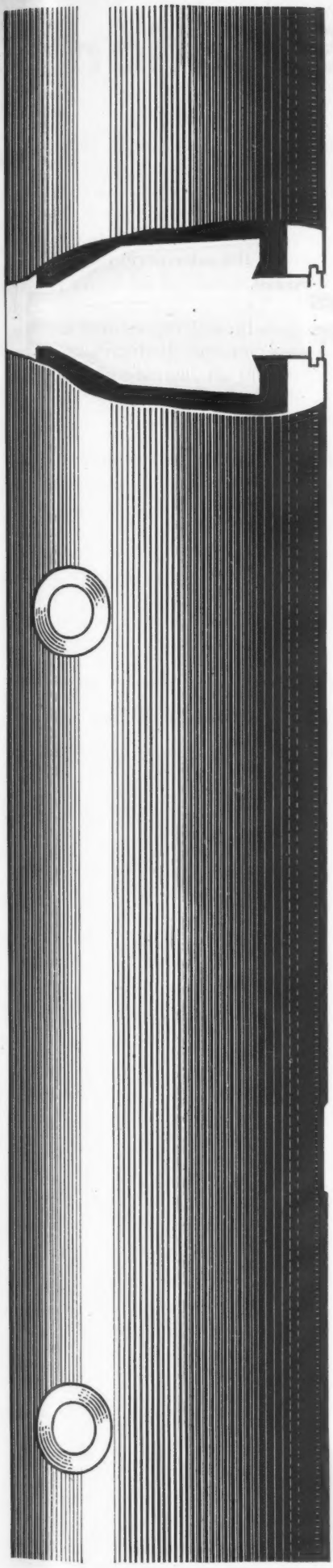
Devise Method of Salvaging Oil from Waste. Valuable oil and wax has been salvaged from settlings in the bottom of oil storage tanks and earthen pits, through a process tested in a Kansas plant by the Bureau of Mines. Research chemists recovered 600 bbl of clean oil from 2000 bbl of pit waste emulsion containing water and dirt. Oil recovered contained 15 to 18 per cent of microcrystalline wax, used in coating food packages, milk cartons, and products shipped to tropical countries. James Boyd, director, Bureau of Mines, has stated that application of the process may enable the oil industry to recover thousands of barrels of useful products from tank and pit settlings and help solve the problem of economic handling and disposal of the waste materials.

Navy Continues Exploration In Elk Hills. Not even $1,500,000,000 could buy the more than 650,000,000 bbl of crude oil the Navy believes is trapped in fault structures below the alkali surface of California's parched Elk Hills, California. The Navy has begun its second year of an $80,000,000 drilling program, purpose of which is to develop oil resources that will be readily available if the U. S. should go to war again. When the field is fully developed, production capacity is expected to exceed 100,000 bbl per day. Present production capacity from the reserves 500 shallow-zone wells is 65,000 bbl a day of 23 gravity oil from an average depth of 3000 ft.

H-Bomb Is Greatest Threat to Oil Fields. If the dreaded hydrogen bomb were ever used in war, it is not unlikely that its most effective use would be in the destruction of rich oil fields in the United States or other parts of the world. One scientist, who declined use of his name, has reported that it is quite practical to anticipate that one H-bomb would be capable of setting fire to every oil well for a distance of 60 miles from the point where it landed. Reason for this is the intense, smoldering heat it generates —heat reported to be same as the estimated surface temperature of the sun, 32 million degrees Centigrade, or in every-day language, 150,000 times hotter than boiling water.

Pressures Drop In Scurry County. Pressures are dropping abnormally in the four Scurry County, Texas, oil fields. Kelley, Diamond M, North Snyder, and Sharon Ridge fields will be closed March 18-26 for pressure tests, the Texas Railroad Commission has announced.

Georgia Offers $100,000 For Oil Well. You can take $100,000 in cash from the State of Georgia today—if you are a lucky wildcatter. That is the amount offered by Georgia to any company or person bringing in a 250-bbl-a-day oil well within the state.



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National Petroleum Situation

By H. J. STRUTH,* Petroleum Economist

Demand Up 5 Per Cent. Demand for all petroleum oils in January was 5 per cent greater than a year ago. Total demand, including exports, averaged about 6,658,000 bbl daily, compared with 6,328,000 bbl a year ago. Further curtailment of domestic production in January reduced the total supply of oils to a daily average of 6,244,000 bbl, which was about 161,000 bbl less than the total reported a year ago, and represented a drop in supply of about 3 per cent. Demand for crude oil in January was 5,620,000 bbl daily, which exceeded the supply by about 193,000 bbl daily.

Improved Fuel Demand. Demand for all fuel oils in December and January showed substantial improvement, due to colder weather in the Midwest and Northeast sections of the United States. Total demand, including exports, in January was 3,130,000 bbl daily, which was about 5 per cent greater than a year ago. Curtailment in refinery production, coupled with the upturn in demand, cut fuel oil stocks in January to the extent of about 17,200,000 bbl. Stocks on January 31 were 118,200,000 bbl, which was about 18 per cent below a year ago. Heavier demand for residual fuels has been accompanied by materially increased imports.

*Petroleum Consultant, Dallas, Texas.

Stocks Sharply Reduced. Stocks of all oils on January 31 aggregated about 590,135,000 bbl, which was 17,447,000 bbl below the level of a year ago. Current stocks represent 89 days supply, compared with 96 days supply a year ago. Stocks were reduced in December and January to the extent of 32,061,000 bbl, whereas in the same period of last year, stocks increased 7,176,000 bbl. Crude oil stocks on January 31 were 247,390,000 bbl, which was a decrease of nearly 6,000,000 bbl during the month, and represented a decline from a year ago of about 4 per cent. Reduced motor fuel demand in January resulted in an increase of more than 12,000,000 bbl in stocks of this product and raised the stock level about 8 per cent above a year ago.

The Market Outlook. Current market outlook favors price stability. Demand this year may be 4 per cent greater than last year; greater supply is justified. There is a world surplus of oil, however, which not only affects American export markets but is a threat to our domestic markets. If foreign oil receipts are held within reasonable limits, greater demand this year should redound to benefit of U. S. producers. Yet, if world surplus breaks foreign markets, the effect would be felt by U. S. producers and refiners.

Comparative Statistics, January, 1950

*All figures are computed on a Bureau of Mines' Basis**

	Jan. 1950Ⓟ	Dec. 1949Ⓟ	Jan. 1949	This Year to date Ⓟ	Last Year to date	Per cent change
Total supply®, all oils	193,578	196,148	198,549	193,578	198,549	— 3
Daily average	6,244	6,327	6,405	6,244	6,405	
Total demand‡, all oils	206,412	215,375	196,156	206,412	196,156	+ 5
Daily average	6,658	6,948	6,328	6,658	6,328	
Change in stocks	—12,834	—19,227	+ 2,393	—12,834	+2,393	— 1
Crude supply®	168,248	170,795	180,196	168,248	180,196	— 7
Daily average	5,427	5,510	5,813	5,427	5,813	
Crude demand‡	174,214	173,449	178,220	174,214	178,220	— 2
Daily average	5,620	5,595	5,749	5,620	5,749	
Crude stocks	247,390	253,356	258,230	247,390	258,230	— 4
Days supply	44	45	45	44	45	
Natural gasoline production	14,700	14,681	12,987	14,700	12,987	+13
Daily average	474	474	419	474	419	
Motor fuel production	83,315	83,515	80,659	83,315	80,659	+ 3
Daily average	2,688	2,694	2,602	2,688	2,602	
Gasoline yield per cent	42.1	43.4	41.1	42.1	41.1	+ 1.0
Motor fuel demand‡	70,690	77,334	67,216	70,690	67,216	+ 5
Daily average	2,280	2,495	2,168	2,280	2,168	
Motor fuel stocks	123,120	110,495	114,444	123,120	114,444	+ 8
Days supply	54	44	53	54	53	
Fuel oil production	71,300	69,283	74,727	71,300	74,727	— 5
Daily average	2,300	2,235	2,411	2,300	2,411	
Fuel oil demand‡	97,040	97,767	92,114	97,040	92,114	+ 5
Daily average	3,130	3,154	2,972	3,130	2,972	
Fuel oil stocks	118,200	135,400	144,092	118,200	144,092	—18
Days supply	38	43	48	38	48	
Refinery still runs	171,750	169,723	174,868	171,750	174,868	— 2
Daily average	5,540	5,475	5,641	5,540	5,641	
Stocks, all oil	590,135	602,969	607,582	590,135	607,582	— 3
Days supply	89	87	96	89	96	

Current Crude Oil Prices

U. S. Average	$2.54	Louisiana	$2.62
Texas	2.61	Arkansas	2.43
California	2.42	New Mexico	2.40
Oklahoma	2.62	Mississippi	2.26
Kansas	2.62	Illinois	2.76
		Other states	2 60

Basic crude prices:	
Oklahoma-Kansas (36 gr.)	$2.57
Texas Gulf Coast (36 gr.)	2.80
East Texas	2.65
West Texas (36 gr.)	2.44
California Signal Hill (36 gr.)	2.31
Pennsylvania, Bradford	3.40

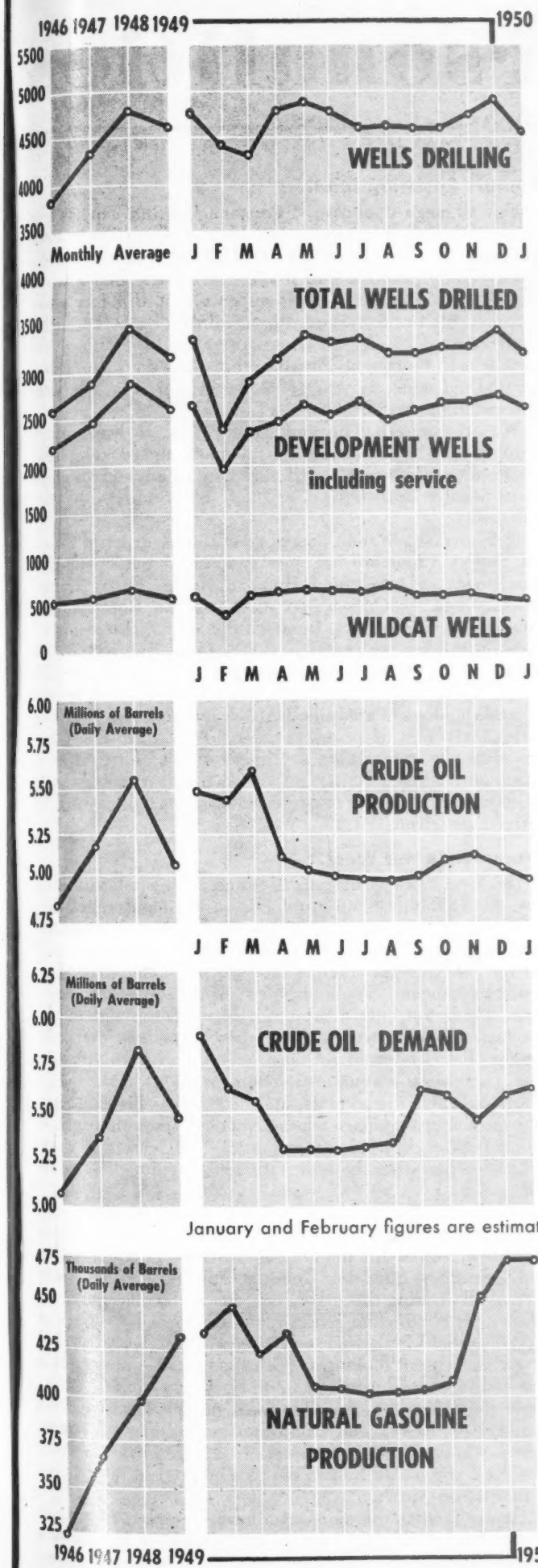
Drilling and Production Statistics

	Jan. 1950Ⓟ	Dec. 1949Ⓟ	Jan. 1949	This Year to date Ⓟ	Last Year to date	Per cent change
Wells Drilling	4,585	4,815	5,040	4,585	5,040	— 9
Total wells drilled	3,255	3,450	3,338	3,255	3,338	— 3
Development wells	2,630	2,761	2,645	2,630	2,645	— 1
Oil	1,818	1,847	1,842	1,818	1,842	—1
Gas	210	243	217	210	217	— 3
Dry	602	671	586	602	586	+ 3
Per cent dry	22.9	24.3	22.8	22.9	22.8	+ 0.1
Service wells	92	109	133	92	133	—31
Wildcat wells	533	580	560	533	560	— 5
Oil	90	84	81	90	81	+11
Gas	20	13	10	20	10	+100
Dry	423	483	469	423	469	—10
Per cent dry	79.4	83.5	83.7	79.4	83.7	— 4.3

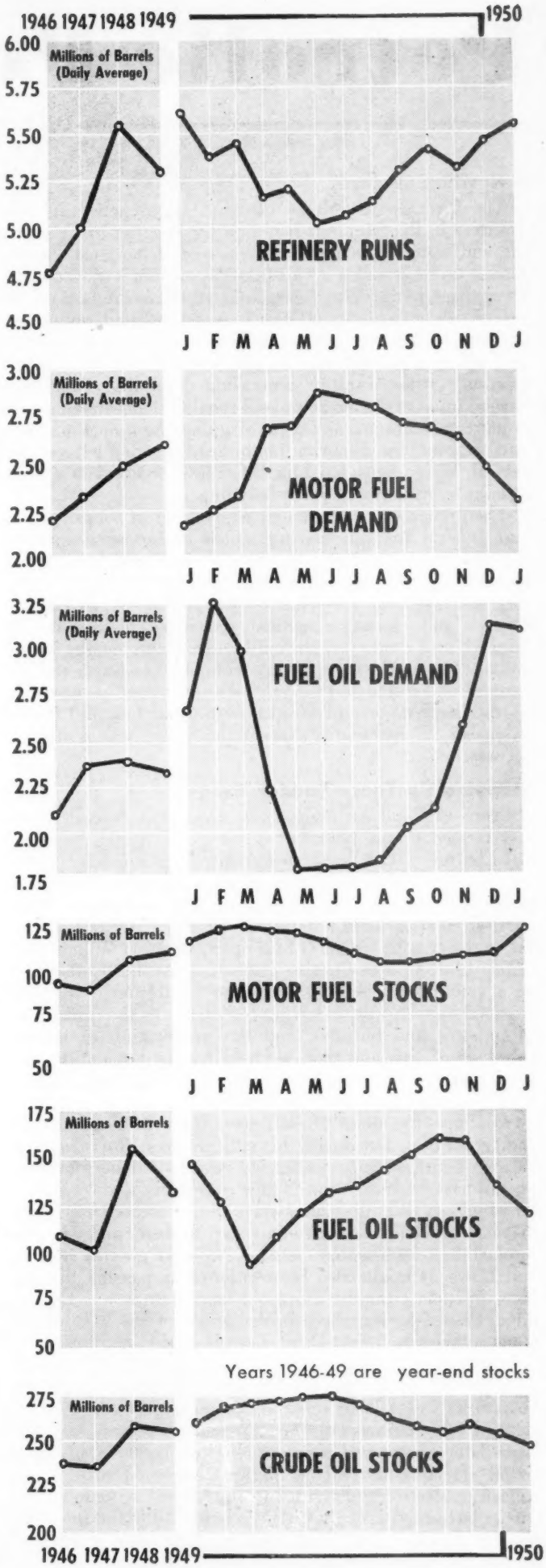
By State

Wells drilled (excl service)	3,163	3,341	3,205	3,163	3,205	— 1
Arkansas	34	20	4	34	4	+750
California	152	174	267	152	267	—43
Illinois	210	256	184	210	184	+14
Kansas	253	330	235	253	235	+ 8
Louisiana	240	244	215	240	215	+12
Mississippi	28	23	29	28	29	— 3
New Mexico	62	37	41	62	41	+51
Oklahoma	370	413	347	370	347	+ 7
Texas	1,256	1,261	1,231	1,256	1,231	+ 2
Other states	558	583	652	558	652	—14
Wildcats drilled	533	580	560	533	560	— 5
Arkansas	10	8	2	10	2	+500
California	26	25	53	26	53	—51
Illinois	47	54	34	47	34	+38
Kansas	40	61	44	40	44	— 9
Louisiana	29	20	19	29	19	+53
Mississippi	7	9	12	7	12	—42
New Mexico	7	5	15	7	15	—53
Oklahoma	70	75	73	70	73	— 4
Texas	211	248	234	211	234	—10
Other states	86	75	74	86	74	+16
Daily crude production	4,968	5,024	5,365	4,968	5,365	— 7
Arkansas	84	82	85	84	85	— 1
California	880	870	941	880	941	— 6
Illinois	175	173	167	175	167	+ 5
Kansas	275	291	284	275	284	— 3
Louisiana	543	560	521	543	521	+ 4
Mississippi	105	105	115	105	115	— 9
New Mexico	136	136	131	136	131	+ 4
Oklahoma	407	416	435	407	435	— 6
Texas	1,991	2,040	2,334	1,991	2,334	—15
Wyoming	142	128	133	142	133	+ 7
Other states	230	223	219	230	219	+ 5

*Unless otherwise stated all figures represent thousands of barrels. Ⓟ-Preliminary. ®Includes domestic production and imports.
‡Total demand, including exports.
Preliminary estimates based upon data supplied by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.



January and February figures are estimates.



Years 1946-49 are year-end stocks

Petrolic Personalities

DICK SNEDDON

A Howling Success

The Chicago Oil Men's Club officially opened its new quarters in the Sheraton Hotel on the evening of February 10, and from all accounts this was one of the most splendiferous wassails since the distant day of Bevo the Beowulf. Over three hundred members and guests swarmed into the extensively enlarged and luxuriously appointed rooms and sank up to their respective necks in a welter of deep plush and soft leather upholstery. After some degree of acclimatization to the rapidly increasing humidity, everybody surged into the dining room and regaled themselves on such epicurean delicacies as breast of guinea hen, neck of barnyard rooster, leg of spring lamb, head of crisp lettuce, and ear of Iowa corn, finishing off these anatomical gastronomics by nibbling on some lady fingers.

The dinner was followed by a program of songs, games, and general joviality during which barber shop quartets sprouted from the lush carpets like asparagus from a hothouse bed, and Adeline was the subject of many a dissonant moan and wavering chord. Jousts of gin rummy, bridge, and canasta occupied the more mathematically minded, and dominoes clicked like castanets during a fandango. The entire donnybrook from start to finish was organized and conducted with the obvious intent of providing unrestricted opportunity for an evening of fun, and in that as in all its incidental aspects the party was a distinct success.

Stepping Up Those Ladder Rungs

From England no less comes word that Norval Myers was elected to the board of directors of Anglo American Oil Company, Ltd., with headquarters in London. Norval is a native of Mount Carroll, Illinois, a graduate of Beloit College, Princeton University, and MIT at Boston. When we first met him back about 1925 he was a research chemical engineer with Union Oil Company down at Wilmington, California. At that time we ourself were thinly disguised as a research chemist in the same institution, and while engaged in such world-shaking researches as the calibration of pipettes and burettes, and the preparation of normal solutions of this and that, we held frequent scientific converse with Norval about atomic bombs, saxophones, English tobaccos, and other matters of moment.

We hope the news doesn't seep back to England and embarrass him, but during his college days, Norval almost became another Rudy Vallee, so sweetly did he tootle the sax. Indeed, he liked what is now commonly known as "the ill wind" so well that he always chose meerchaum pipes that had a decided saxophonic sweep to them, and when he smoked them he fingered them as if he were playing Buttons and Bows. It might also be mentioned in passing that his favorite stuffing for the aforesaid meerchaums was English tobacco, and he searched the hangouts of the wooden Indians ceaselessly for Anglican brands of the soothing weed.

In due course, to continue the narrative. Norval became manager of manufacturing for Union and was much too busy to let us smell his tobacco any more. Then in 1941 he skipped to Standard Oil Development Company, and five years later was named assistant chief engineer. In his most recent elevation he will be mainly concerned with Anglo American's refining activities in the United Kingdom, and particularly the plant that is now being built for the company at Fawley, near Southampton. This when completed will be the largest petroleum refinery in Europe.

Rumors Resisting Dilution

Our Chicago operative, Silvertone Perkins, reports that he recently called briefly on Bill Murray, long time general manager of the lubricating oil sales department of Deep Rock Oil Corporation and found him busier than a woodpecker on a steel derrick. It appears that Bill has added considerably to his normal responsibilities by accepting the chairmanship of the API committee on lubrication, and now he is so thoroughly involved that a few days ago, before he realized what he was doing, he grabbed the telephone and called up an SAE number.

We are interested no end, by the way, to learn of the development of crankcase oils that are almost completely resistant to dilution. After all, anything or anybody that can resist dilution in these tippling times, is certainly to be commended.

Still hovering in the Chicago area, Gene Harper of Franklin Supply Company has just announced the opening of new stores at Odessa and Houston, Texas. Frank Dorney will manage the Odessa operation, and Ed Robinson will take charge at Houston. Immediately after making this expansion public, the genial Franklin prexy jumped aboard his flying carpet and was whisked off to Arizona and California for a three weeks tour. We understand that by way of anthropological study he will search these two primitive states for traces of people. Personally we have never had any difficulty discovering lost races. All we have to do is barge out to Santa Anita and bet on the "sure things" that are given to us in the strictest confidence by our better informed oil friends.

Drammer in the West

The west coast is literally seething with small talk these days about the dramatic productions of a handsome blade, known as Al Ziegfeld Jensen, who has some sort of attachment with Consolidated Steel; is in charge of entertainment for the Nineteeners; and has more histrionic hep than Sheriden, Shakespeare, Shadrach, Mesach, and Abednego, combined. Al is not only a producer of amazingly spectacular spectacles, but he writes them himself, assigns the parts, coaches the hams, and shushes the audience into attentiveness. He seizes upon interesting current events as the themes of his skillfully woven plots, and he sketches his characters with a daring that hasn't been equalled since the days of Jenny Geddes. Several of the most recent Jensenian works have been based on the now nationally famous "Norris Incident."

It appears, try and stop us if you have heard it, that Ken "Thermic Ray" Norris dashed madly to Bakersfield one afternoon, bound for the annual Nineteeners' Convocation and Calcutta at Stockdale Country Club. He had first taken care of all pending executive decisions at the office, and was enjoying a comforting sense of release when he arrived at the Bakersfield Inn. His reservation was OK, so he checked in and then went looking for Nineteeners. He noticed that things were suspiciously quiet and he simply couldn't understand the absence of familiar faces until he consulted the manager of the Inn and found that he had arrived exactly a week too soon. Since that fateful day, Ken has had more ribs than you would find in the paleontological department of the British Museum.

Among famous thespians who have recently participated in the Jensen charades are such notables as Ken Norris whose portrayal of a brusque but confused business man

OIC

PACE SETTER IN VALVES

Engineered FOR LASTING SERVICE

200 LB. UNION BONNET BRONZE GATE VALVE

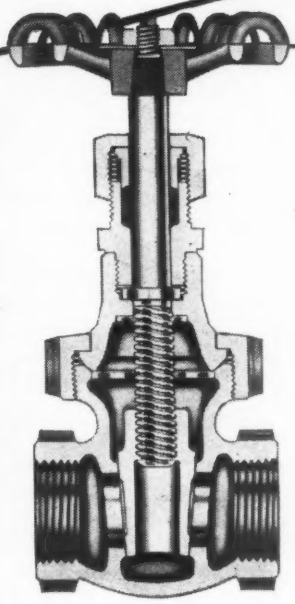


FIGURE NO. 7208
Non-rising stem, integral seat, OIC nickel alloy solid wedge, screwed end type.

FIGURE NO. 7200
Rising stem, integral seat, OIC nickel alloy solid wedge, screwed end type.

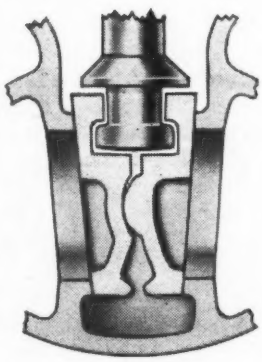
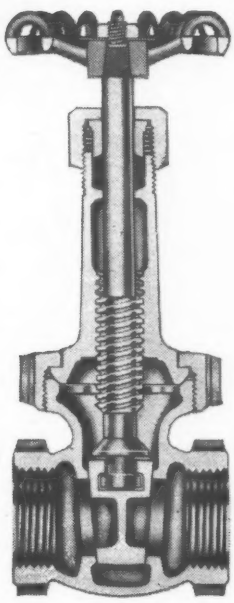


FIGURE NO. 7202
OIC Nickel Alloy double taper wedge automatically adjusts itself to its seat as valve is closed.



DESIGN: Solid wedge, rising stem; double-tapered wedge, rising stem; or solid wedge, non-rising stem. Integral seat, screwed end design.

BODIES: Of Steam Bronze ASTM B61, with average tensile strength of 40,000 lbs.

BONNETS: Also of Steam Bronze, with seal on lower end which mates with corresponding surface on stem to allow valve to be packed while fully open and under pressure. Condensing chamber below the stuffing box to keep packing cooler on high-temperature lines.

GATES: Of two types.

SOLID WEDGES are OIC copper nickel alloy, are of I-beam design, and reversible.

DOUBLE-TAPERED WEDGES fit into same bodies, but have ball and socket design, allowing wedge automatically to adjust itself to seat as valve closes. Accurately machined guides on both types, and tapered seating surfaces to give full contact with body seats as the wedges wear.

STEMS: Of manganese bronze, with double Acme thread for quick traverse of the wedge. Diameters sufficient to bear torsional loads greater than strongest hand pressure and to withstand severe operating conditions.

SEATING SURFACES: Machined to five-degree, self locking angle.

HANDWHEELS: Of ventilated malleable iron, finished in black enamel.

RATINGS: For steam at 200 lbs., 550 degrees F.; for cold water, oil, or non-shock gas service at 400 lbs. Shell tested at 500 lbs. and seat tested at 400 lbs.

SIZES: One-fourth inch to three inches currently available.

Special **INTRODUCTORY OFFER**

Check this 200-lb. Union Bonnet Bronze valve. Send us the size, and we'll deliver you a sample on memo billing. Keep it 30 days, take it apart, analyze it, test it. After you've examined all its superiorities, you may return it, if you wish, for full credit.

OIC **VALVES**

THE OHIO INJECTOR CO.
100 S. LYMAN STREET WADSWORTH, OHIO

BRONZE • CAST STEEL • FORGED STEEL • IRON

0-1149-23

had all the business men in the audience brusque and confused, and almost brought him the academy award; Bill Farrar, who played the coy stenographer with more allure—and artificial equipment—than Jane Russell, is of course, an old trouper. He had his own theatrical company touring the G. I. camps during the late lamented world war. Jock McLeod, the Macco chief—his inimitable delineation of a despondent Scot about to jump from the Brooklyn Bridge probably inspired "The Hasty Heart;" Tom Bell, erstwhile Jones and Laughlin attache, another Caledonian with even more heather between his toes, and more burrs in his speech than a wandering sheep dog; Len Price, transplanted Richfield oiler, who can hold a note longer than the loan department of the local banks. Scientists claim that in his popular rendition of Mule Train, Len produces more decibels than did the atom bombing of Hiroshima.

Look for H. J. Struth's annual review of reserves discoveries and analysis of oil finding costs in the April issue. New data in preparation by the nationally known petroleum economist will be of unusual interest.

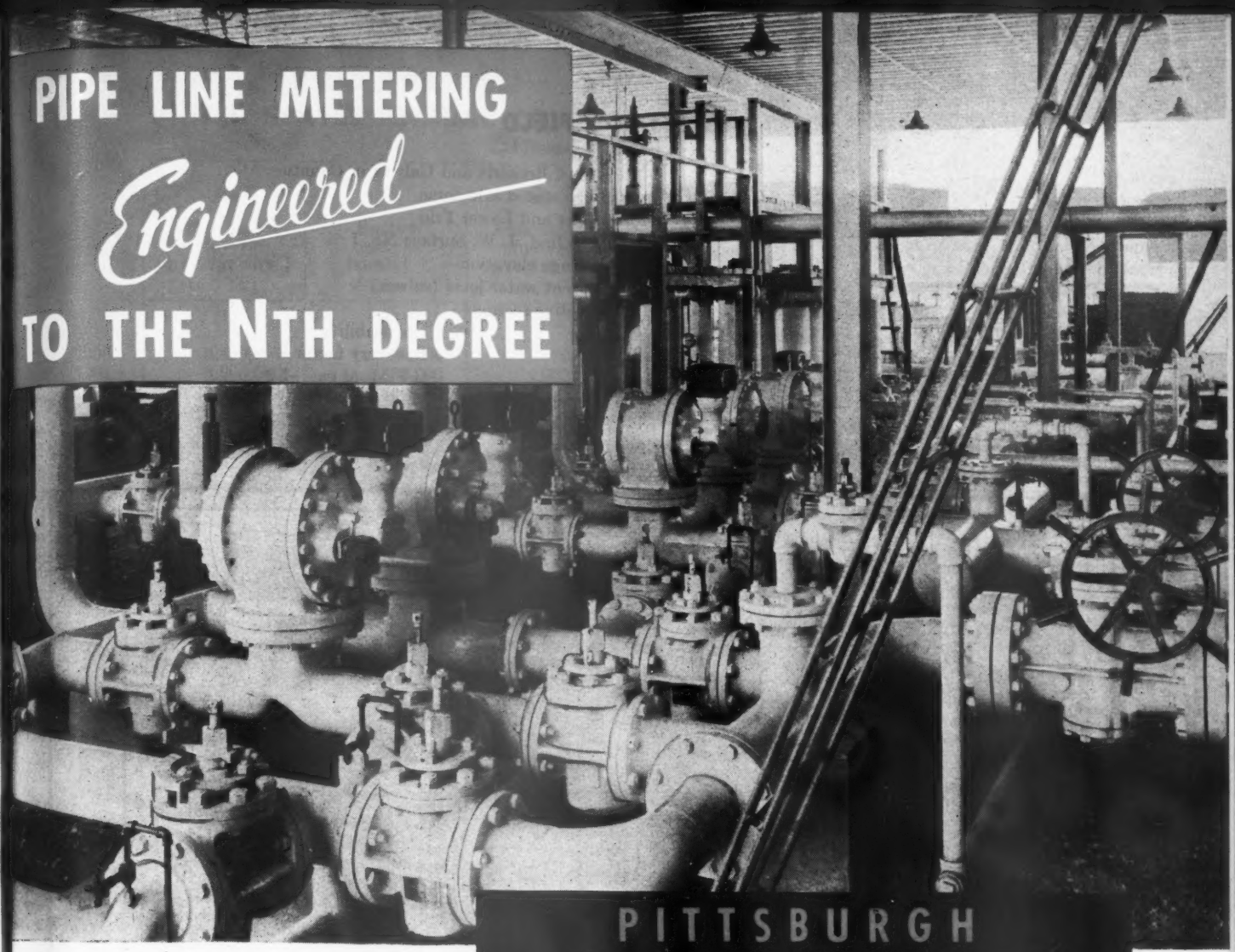
Racoon Coats and a Silver Flask

One of the more recent Jensen shows was a travesty, or something equally terrible, on campus life at Harvard School of Business Administration. It featured Charlie "Big Shot" Perkins, complete with coonskin coat, golf bag, and beanie, in the difficult role of Paul Huggins. The whole story, so called, centered around the efforts of Paul to register in the college that has no r's in its curriculum, and Charlie's efforts to ingratiate himself with the profs was a masterpiece of the fine art of mining that floored most of the dramatic critics, and came darned near flooring Charlie. In his supporting cast was that oratorical smoothie, Joe Aderhold of Allied Supply, who took the part of the University prexy as if he were one. Joe really does have an unusual command of English and we have noted that even when he isn't acting it is quite easy for him to say "Hahvahd," an unquestionable indication of the higher intellect.

Also among the *dramatis personae* was Tut Tuttle, present head of the Los Angeles purchasing agents, and as fine a violinist as ever busted an E string. Tut, appropriately enough, was in charge of the College music department, and before he was through he had the California freshman feeling lower than a base clef. Especially hot was Bill Conroy, the Wilshire Hibernian, an excellent dialectician. Bill played the part of a Palestinian psychiatrist and he had more instruments than Sousa's band to help him in his profession.

Kidding aside, this lad is a real performer, and if the TV talent scouts don't grab him PDQ they are certainly off the BEAM. The same may be said of Hal Lindquest, the Swedish scientist, whose recitals of boyhood adventures in Scandinavia have been a feature of the Nineteener after-dinner entertainment for some time. Then there was George Trembley of Howard Supply, the Jacoby of the gin rummy set, and a capable performer with a mashie. George played the part of the Harvard athletic director with all the delicacy of an eight foot putt—that just rimmed the cup. And last, but by no means least is Al "Dutch" Zwerneman, the Axelsnoian Adonis, one of the most completely accomplished men in these parts. Al is well known and well liked in all strata of petrolic society, and it all stems from the simple face that besides being a thoroughly personable chap himself, he seems to have a genuine interest in everything and everybody. Anyway, as Beulah, the janitor's wife, he proved that he can handle a difficult role with *savoir faire* and stuff like that there.

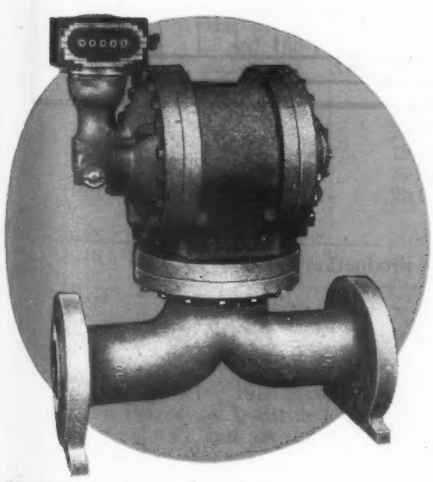
PIPE LINE METERING *Engineered* TO THE NTH DEGREE



Meter bank on Plantation line. Model 6 PL Rotocycles with straight reading registers and temperature compensators are used.

PITTSBURGH ROTOCYCLE METERS

COUNT OUT THE BARRELS AS THEY ROLL THROUGH THE LINE



Model 6 PL Rotocycle with large straight reading re-set register—capacity 1150 barrels per hour. Three smaller sizes available. Ticket printers and other type registers optional.

The battery of Rotocycle meters pictured is typical of hundreds of installations on major pipe lines throughout the country. Here is measurement engineering at its finest. The battery type installation assures stand-by equipment available for maintenance, proving and shut downs. The size and number of Rotocycle meters has been carefully calculated in relation to full line capacity. Manifolding is flexible. All lines are under the quick, positive control of Nordstrom valves. Want the finest pipe line meters and the all-important measurement engineered installations that go with them? Then get in touch with our nearest District Office.

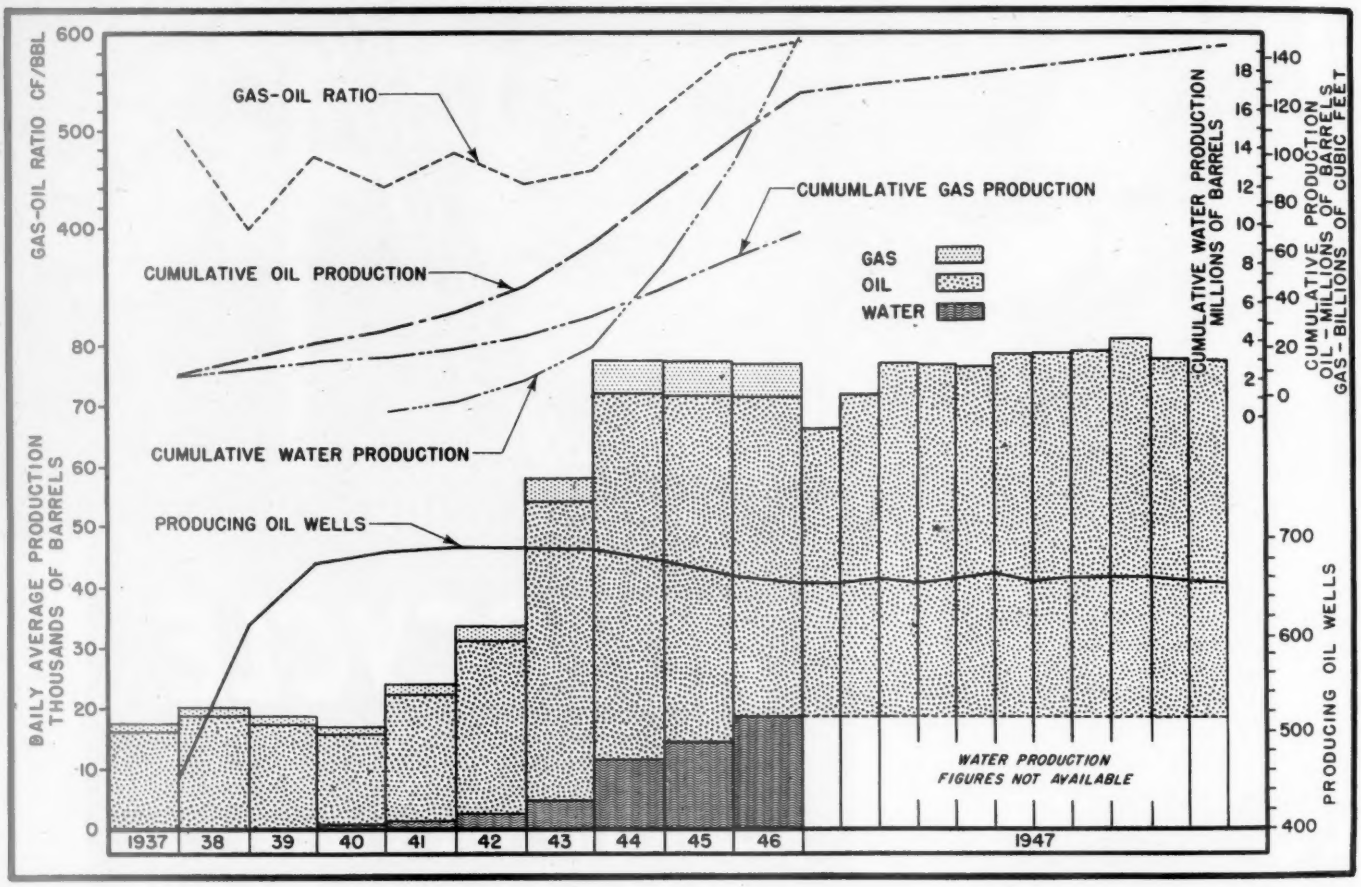
Pittsburgh Equitable Meter Division — ROCKWELL MANUFACTURING COMPANY

Pittsburgh 8, Pa.

Atlanta Boston Chicago Columbus Houston Kansas City Los Angeles New York Pittsburgh San Francisco Seattle Tulsa

HASTINGS FIELD

Location —Texas. Brazoria and Galveston Counties
Type of structure —Deep seated salt dome
Producing formation —Upper and Lower Frio
Discovery well —Stanolind, J. W. Surface No. 1
Current spacing pattern—10 acres —Average elevation—
Original water level (subsea)— —Current water level (subsea)—
Top of porosity (subsea)— —Effective section—
Bottom hole temperature— Average porosity— Permeability—
Connate water— Form volume factor— Recovery factor—
Gravity of oil—31° API Gravity of gas—0.6 G.P.M. of gas—1.2
Original operating GOR—480 —Current operating GOR—
Reservoir pressure (subsea datum)—6,000′ —Original— Current—


GAS-OIL RATIO CF/BBL
GAS-OIL RATIO
CUMULATIVE OIL PRODUCTION
CUMUMLATIVE GAS PRODUCTION
CUMULATIVE WATER PRODUCTION
PRODUCING OIL WELLS
GAS
OIL
WATER
WATER PRODUCTION FIGURES NOT AVAILABLE
DAILY AVERAGE PRODUCTION THOUSANDS OF BARRELS
CUMULATIVE WATER PRODUCTION MILLIONS OF BARRELS
CUMULATIVE PRODUCTION OIL-MILLIONS OF BARRELS GAS-BILLIONS OF CUBIC FEET
PRODUCING OIL WELLS
1937 38 39 40 41 42 43 44 45 46 1947

PRODUCTION STATISTICS

Date	Producing oil wells	Daily average production			Cumulative production			GOR
		Oil (M bbl)	Gas (MMCF)	Water (M bbl)	Oil (M bbl)	Gas (MMCF)	Water (M bbl)	
1937	453	16.06	8.10		8,912	8,345		505
1938	612	18.84	7.54		15,790	11,096		400
1939	674	17.38	8.27		22,137	14,114		475
1940	687	14.78	6.53	1.03	27,548	16,505	376	442
1941	692	20.89	10.03	1.33	35,174	20,166	863	480
1942	690	28.55	12.75	2.65	45,593	24,820	1,832	447
1943	689	49.31	22.74	4.88	63,589	33,119	3,612	461
1944	678	60.59	31.70	11.53	85,765	44,723	7,832	523
1945	662	57.40	33.29	14.36	106,715	56,875	13,072	580
1946	654	52.95	31.50	18.60	126,040	68,373	19,862	595
1947	646	58.60	—	—	147,426	—	—	—

Source: Stanolind Oil & Gas Company.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

UNITED STATES ANNUAL CRUDE OIL RESERVES AND DISCOVERIES

(Thousands of Barrels)

Year	Accumulated discoveries up to January 1	Proved reserves January 1	Accumulated production up to January 1	Annual discoveries including new pools, extentions, and revisions	Annual production	Ratio: Proved reserves to annual production	Year
	(1)	(2)	(3)	(4)	(5)	(6)	
1900	3,439,984	2,500,000	939,984	463,621	63,621	42.4	1900
1901	3,903,605	2,900,000	1,003,605	169,389	69,389	42.5	1901
1902	4,072,994	3,000,000	1,072,994	288,767	88,767	34.9	1902
1903	4,361,761	3,200,000	1,161,761	300,461	100,461	32.8	1903
1904	4,662,222	3,400,000	1,262,222	317,081	117,081	29.9	1904
1905	4,979,303	3,600,000	1,379,303	334,717	134,717	27.5	1905
1906	5,314,020	3,800,000	1,514,020	126,494	126,494	30.0	1906
1907	5,440,514	3,800,000	1,640,514	266,095	166,095	23.2	1907
1908	5,706,609	3,900,000	1,806,609	278,527	178,527	22.1	1908
1909	5,985,136	4,000,000	1,985,136	383,171	183,171	22.4	1909
1910	6,368,307	4,200,000	2,168,307	509,557	209,557	20.8	1910
1911	6,877,864	4,500,000	2,377,864	720,449	220,449	21.5	1911
1912	7,598,313	5,000,000	2,598,313	622,935	222,935	23.3	1912
1913	8,221,248	5,400,000	2,821,248	348,446	248,446	21.9	1913
1914	8,569,694	5,500,000	3,069,694	165,763	265,763	20.5	1914
1915	8,735,457	5,400,000	3,335,457	381,104	281,104	19.4	1915
1916	9,116,561	5,500,000	3,616,561	700,767	300,767	19.0	1916
1917	9,817,328	5,900,000	3,917,328	335,316	335,316	17.6	1917
1918	10,152,644	5,900,000	4,252,644	655,928	355,928	17.0	1918
1919	10,808,572	6,200,000	4,608,572	878,367	378,367	17.0	1919
1920	11,686,939	6,700,000	4,986,939	942,929	442,929	15.7	1920
1921	12,629,868	7,200,000	5,429,868	1,072,183	472,183	15.9	1921
1922	13,702,051	7,800,000	5,902,051	357,531	557,531	13.8	1922
1923	14,059,582	7,600,000	6,459,582	732,407	732,407	10.4	1923
1924	14,791,989	7,600,000	7,191,989	613,940	713,940	10.6	1924
1925	15,405,929	7,500,000	7,905,929	1,763,743	763,743	10.5	1925
1926	17,169,672	8,500,000	8,669,672	1,070,874	770,874	11.2	1926
1927	18,240,546	8,800,000	9,440,546	2,601,129	901,129	10.7	1927
1928	20,841,675	10,500,000	10,341,675	1,401,474	901,474	11.9	1928
1929	22,243,149	11,000,000	11,243,149	3,207,323	1,007,323	12.0	1929
1930	25,450,472	13,200,000	12,250,472	1,298,011	898,011	14.9	1930
1931	26,748,483	13,600,000	13,148,483	251,081	851,081	15.6	1931
1932	26,999,564	13,000,000	13,999,564	85,159	785,159	16.1	1932
1933	27,084,723	12,300,000	14,784,723	605,656	905,656	13.4	1933
1934	27,690,379	12,000,000	15,690,379	1,085,065	908,065	13.3	1934
1935	28,775,444	12,177,000	16,598,444	1,219,596	996,596	12.3	1935
1936	29,995,040	12,400,000	17,595,040	1,763,087	1,099,687	11.6	1936
1937	31,758,127	13,063,400	18,694,727	3,723,028	1,279,160	11.2	1937
1938	35,481,155	15,507,268	19,973,887	3,055,233	1,214,355	13.5	1938
1939	38,536,388	17,348,146	21,188,242	2,399,828	1,264,962	14.2	1939
1940	40,936,216	18,483,012	22,453,204	1,894,717	1,353,214	13.9	1940
1941	42,830,933	19,024,515	23,806,418	1,967,009	1,402,228	13.8	1941
1942	44,797,942	19,589,296	25,208,646	1,880,142	1,386,645	14.3	1942
1943	46,678,084	20,082,793	26,595,291	1,486,972	1,505,613	13.3	1943
1944	48,165,056	20,064,152	28,100,904	2,066,983	1,677,753	12.1	1944
1945	50,232,039	20,453,231	29,778,808	2,087,237	1,713,655	12.0	1945
1946	52,319,276	20,826,813	31,492,463	2,831,480	1,733,939	12.3	1946
1947	55,150,756	21,924,354	33,226,402	2,664,438	1,856,107	12.0	1947
1948	57,815,194	22,732,685 ②	35,082,509	..	..	..	1948

(1) Accumulated production up to January 1 plus proved reserves as of January 1.

(2) Figure for 1936 is estimate of *The Lamp* — Standard Oil Company (N. J.); all others from 1935 to 1946 are estimates of the American Petroleum Institute's Committee on Petroleum Reserves. Figures for years previous to 1935 are estimates of the Department of Statistics, API, but are not based on geological surveys.

(3) Accumulated production to January 1 of previous year plus production during previous year.

(4) Proved reserves of following year minus proved reserves of current year plus production of current year.

(5) U. S. Bureau of Mines.

②Estimated.

Source: As noted in footnotes above.

Note: In an attempt to keep 1948 figures on a reasonably comparable basis *The Petroleum Data Book* has included an estimated quantity of 1,245,000 M bbl of cycle-plant and lease condensate reserves with the 21,487,685 M bbl of crude oil reserves. For further explanation of reserve estimates see subsequent pages in this section.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

Dry holes, reserves discovered, production—1916-1947, inclusive. (Revised 1947)

Year	Dry holes drilled*	New reserves discovered† (millions)	Dry holes per million barrels	Annual production (millions)	Surplus or short (millions)	Reported reserves inventory‡ Dec. 31 (millions)	Adjusted reserves inventory, Dec. 31 (millions)
1916	4,039	250	16	301	— 51	5,900	5,290
1917	4,851	950	5	335	+ 615	5,900	5,905
1918	5,631	400	14	356	+ 44	6,200	5,949
1919	5,986	800	7	378	+ 422	6,700	6,371
1920	7,346	900	8	443	+ 457	7,200	6,828
Total 5 years	27,853	3,300		1,813	+1,487		
Annual average	5,571	660	8	363	+ 297		
1921	5,160	1,300	*4	472	+ 828	7,800	7,656
1922	5,332	900	5	557	+ 343	7,600	7,899
1923	5,883	900	6	732	+ 168	7,600	8,167
1924	5,044	700	7	714	— 14	7,500	8,153
1925	6,734	800	8	764	+ 36	8,500	8,189
Total 5 years	28,153	4,600		3,239	+1,361		
Annual average	5,631	920	6	648	+ 272		
1926	7,965	2,900	4	771	+2,129	8,800	10,318
1927	7,210	1,100	6	901	+ 199	10,500	10,517
1928	7,078	2,550	3	901	+1,649	11,000	12,166
1929	7,914	1,800	4	1,007	+ 793	13,200	12,959
1930	6,734	6,000	1	898	+5,102	13,600	18,061
Total 5 years	36,901	14,350		4,478	+9,872		
Annual average	7,380	2,870	2	896	+1,974		
1931	3,609	1,600	2	851	+ 749	13,000	18,810
1932	3,469	500	7	785	— 285	12,300	18,525
1933	3,112	700	4	906	— 206	12,000	18,319
1934	4,012	1,800	2	908	+ 892	12,177	19,211
1935	4,286	2,325	2	997	+1,328	12,400	20,539
Total 5 years	18,488	6,925		4,447	+2,478		
Annual average	3,698	1,385	3	889	+ 495		
1936	4,573	2,305	2	1,100	+1,205	13,063	21,744
1937	4,971	2,629	2	1,278	+1,351	15,507	23,095
1938	5,355	2,920	2	1,213	+1,707	17,348	24,802
1939	4,937	2,376	2	1,264	+1,112	18,483	25,914
1940	4,670	1,936	2	1,352	+ 584	19,024	26,498
Total 5 years	24,506	12,166		6,207	+5,959		
Annual average	4,901	2,433	2	1,241	+1,192		
1941	4,519	1,750	3	1,404	+ 346	19,589	26,844
1942	3,772	1,345	3	1,385	— 40	20,083	26,804
1943	4,719	1,147	4	1,503	— 356	20,065	26,448
1944	7,010	1,202	6	1,678	— 476	20,453	25,972
1945	7,646	1,125	7	1,737	— 612	20,826	25,360
Total 5 years	27,666	6,569		7,707	—1,138		
Annual average	5,533	1,314	4	1,541	— 227		
1946	8,764	714	12	1,740	—1,026	21,949	24,334
1947 ℗	9,857	875§	11	1,865	— 990	23,344	23,344
Total 2 years	18,621	1,589		3,605	—2,016		
Annual average	9,310	795	12	1,802	—1,008		

*Excluding service wells. †Extensions and revisions credited to years of original discovery.

‡Reported by A.P.I. Reserves Committee, 1946 and 1947 estimated by author.

§Provides for subsequent extensions and revisions of about 350 million barrels. ℗Preliminary estimate.

Reserve discoveries related to all drilling. (Annual averages)

Period	All wells drilled*	Oil wells completed	Reserves found (millions)	Average reserves discovered per well		
				All wells	Oil wells	Dry holes
1916–20	27,359	19,732	660	24,124	33,448	118,471
1921–25	23,715	15,872	920	38,794	57,964	163,381
1926–30	24,678	14,634	2,870	116,298	196,118	388,889
1931–35	15,625	10,595	1,385	88,640	130,722	374,527
1936–40	27,477	18,997	2,433	88,547	128,073	496,429
1941–45	22,608	13,099	1,314	58,121	100,313	237,484
1946–47	29,744	17,035	795	26,728	46,669	85,392

*Excluding service wells. Source: H. J. Struth, *The Petroleum Engineer* January, 1948.

From The Petroleum Data Book, Second Edition, which carries 750 pages of information on the petroleum industry.

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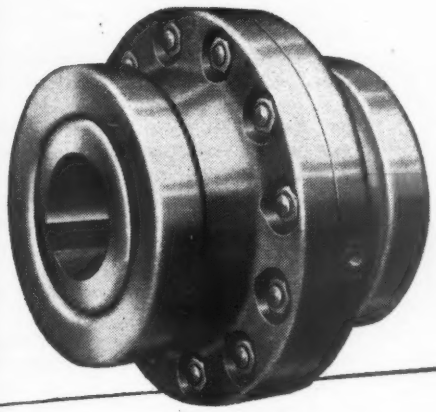

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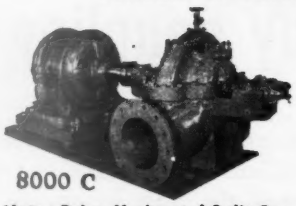
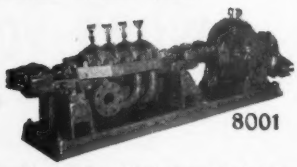


8000 C

Motor Drive Horizontal Split Case Double Suction Centrifugal Pump

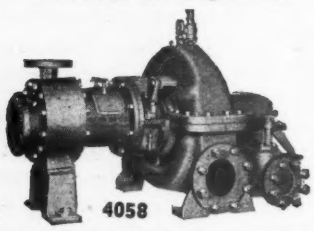


8001

Turbine Drive Horizontal Split Case Multi Stage Centrifugal Pump

4049 A

Two Stage Close Coupled Centrifugal Pump



4058

Turbine Drive Close Coupled Centrifugal Pump

942

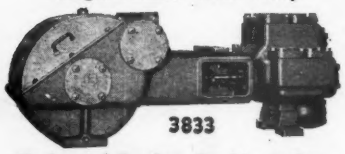
Single Style, Packed Piston Pattern Steam Pump

2352 B

Durable Duplex, Outside End Packed, Plunger Pattern Steam Pump

3918

Durable Duplex, Packed Piston Pattern Steam Pump



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MEETINGS

Mar. 25—North Texas Oil and Gas Assn, Annual Meeting, Kemp Hotel, Wichita Falls.

Mar. 26-30—American Chemical Society, 1st Session, National Meeting, Houston, Texas.

Mar. 27-29—Western Petroleum Refiners Assn, Annual Meeting, Plaza Hotel, San Antonio, Texas.

Mar. 27-29—Southern Gas Association, Galveston, Texas.

Mar. 29-31—API, Production Division, Mid-Continent District, Skirvin Hotel, Oklahoma City, Okla.

Apr. 3-4—API, Board of Directors Meeting, Houston, Texas.

Apr. 3-5—American Gas Assn, Distribution Motor Vehicle and Corrosion Conference, Hotel Book-Cadillac, Detroit, Michigan.

Apr. 4-7—National Assn of Corrosion Engineers, Annual Conference and Exhibition, Jefferson Hotel, St. Louis, Mo.

Apr. 5-7—Midwest Power Conference, Illinois Inst. of Technology, Sherman Hotel, Chicago.

Apr. 9-13—American Chemical Society, 2nd Session, National Meeting, Philadelphia, Pa.

Apr. 10-12—American Society of Lubrication Engineers, Annual Meeting, Hotel Statler, Detroit, Mich.

Apr. 10-14—ASME, Hotel Statler, Washington, D. C.

Apr. 11-13—Southwestern Gas Measurement, Short Course, University of Oklahoma, Norman, Okla.

Apr. 12-14—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.

Apr. 13-14—API, Production Division, Rocky Mountain District, Gladstone Hotel, Casper, Wyoming.

Apr. 16-20—American Chemical Society, 3rd Session, National Meeting, Detroit, Mich.

Apr. 18-20—Petroleum Industry Electrical Assn-Petroleum Electric Supply Assn, Joint Meeting and Exhibits, Shamrock Hotel, Houston.

Apr. 24-25—Industrial Accident Prevention Assn, Royal York Hotel, Toronto, Canada.

Apr. 24-26—NGAA, Annual Convention, Texas Hotel, Fort Worth, Texas.

Apr. 24-27—AAPG, Society of Economic Paleontologists, and Society of Exploration Geophysicists, Annual Meeting, Stevens Hotel, Chicago, Ill.

Apr. 24-May 1—Oil Heat Institute of America & National Oil Heat Exposition, Annual Meeting, Commercial Museum, Philadelphia.

Apr. 26-28—API, Production Division, Eastern District, Cleveland Hotel, Cleveland, Ohio.

Apr. 28-29—Indiana Gas Assn, French Lick Springs Hotel, French Lick, Indiana.

May 1-4—API, Refining Division, Mid-Year Meeting, Hotel Cleveland, Cleveland, Ohio.

May 1-4—American Geophysical Union, Annual Meeting, Washington, D. C.

May 4-6—Interstate Oil Compact Commission, Spring Meeting, Buena Vista Hotel, Biloxi, Miss.

May 7-9—IPAA, Mid-Year Meeting, Biltmore Hotel, Los Angeles, Calif.

May 7-9—National Stripper Well Association, Biltmore Hotel, Los Angeles, Calif.

May 8-9—A.G.A., Natural Gas Dept., Spring Meeting, The Mayo, Tulsa, Okla.

May 8-11—Liquefied Petroleum Gas Assn, Annual Convention and Trade Show, Palmer House, Chicago, Illinois.

May 11-12—API, Division of Production, Spring Meeting, Biltmore, Los Angeles, Calif.

May 11-12—American Gas Assn, Executive Conference, The Broadmoor, Colorado Springs, Colorado.

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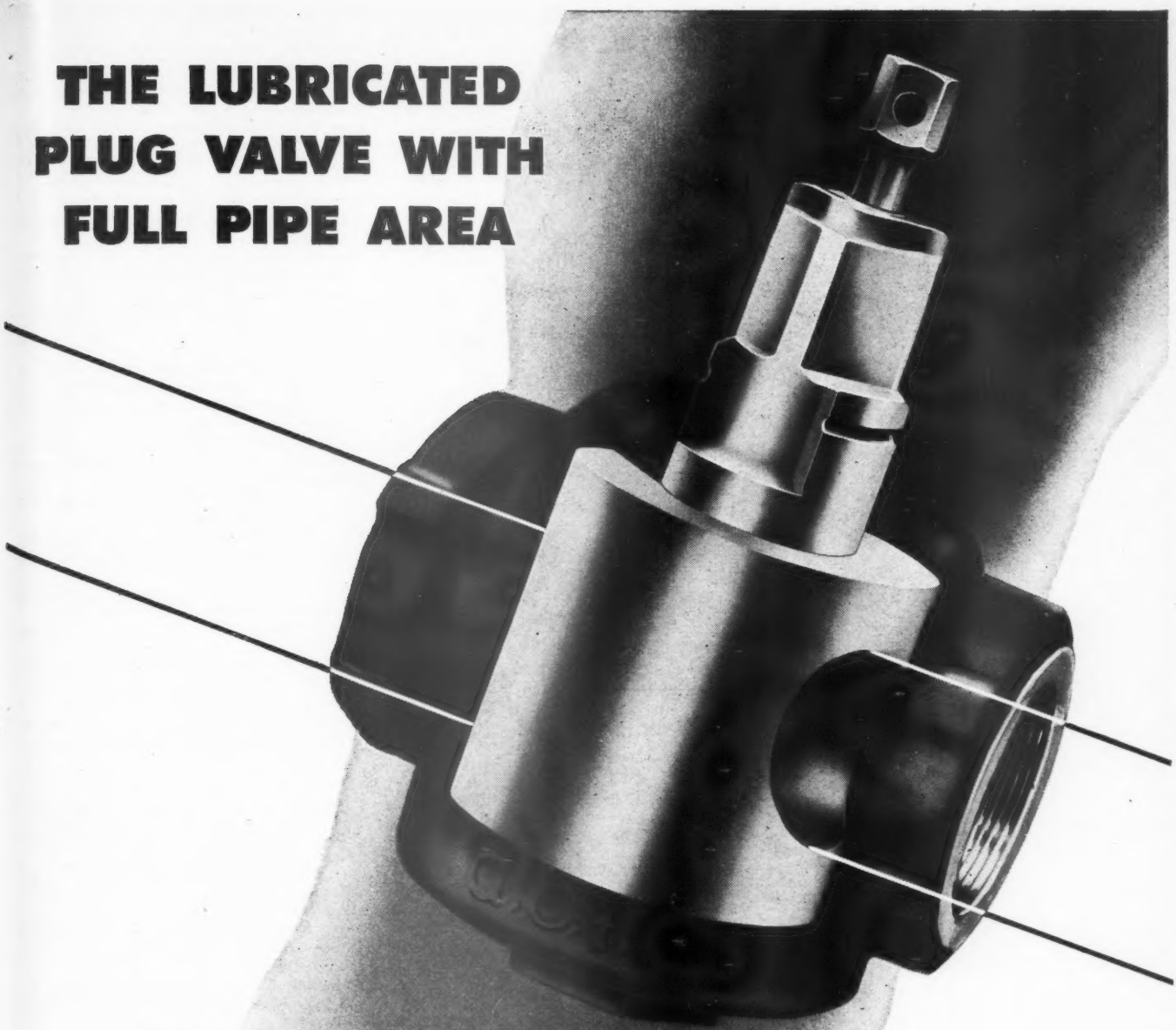

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May 15-17—Oil Industry Information Committee, Chicago, Ill.
May 29-31—Fifth Annual Short Course in Gas Technology, Texas A & I, Kingsville, Texas.
June 4-9—SAE, Summer Meeting, French Lick Springs Hotel, French Lick, Indiana.
June 8-10—National Oil Scouts and Landmen's Assn, Oklahoma City, Okla.
June 12-16—ASME, Oil and Gas, Power Division, Lord Baltimore Hotel, Baltimore, Md.
June 12-16—AIEE, Summer and Pacific General Meeting, Huntington Hotel, Pasadena, California.
June 15-16—Pennsylvania Grade Crude Oil, Annual Meeting, Hotel William Penn, Pittsburgh, Penn.
June 18-20—Petroleum Equipment Suppliers Assn, The Greenbrier, White Sulphur Springs, W. Va.
June 19-23—ASME, Hotel Statler, St. Louis, Mo.
June 20-24—Canadian Gas Assn, Annual Meeting, Manoir Richelieu, Murray Bay, Quebec, Canada.
June 26-30—API, Production Division, Mid-Year Standardization Conference, Brown Palace Hotel, Denver, Colorado.
Aug. 14-16—SAE, West Coast Meeting, Biltmore Hotel, Los Angeles, Calif.
Sept. 5-9—National Chemical Exposition, Chicago Section, American Chemical Soc., Coliseum, Chicago, Ill.
Sept. 11-13—Oil Industry Information Committee, Hotel Traymore, Atlantic City, N. J.
Sept. 13-15—National Petroleum Assn, Hotel Traymore, Atlantic City, N. J.
Sept. 18-22—Instrument Conference and Exhibit, Instrument Society of America, Memorial Auditorium, Buffalo, New York.
Sept. 25-27—ASME, Petroleum Mechanical Engineering Division, The Roosevelt Hotel, New Orleans, Louisiana.
Oct. 2-6—AGA, Annual Convention, Atlantic City, N. J.
Oct. 2-6—Mid-Continent Oil and Gas Assn, Louisiana-Arkansas division, The Roosevelt Hotel (tentative), New Orleans, La.
Oct. 4-5—Mid-Continent Oil and Gas Assn, Texas Division, Baker Hotel (tentative), Dallas, Texas.
Oct. 9-10—American Assn of Oilwell Drilling Contractors, Annual Meeting, The Mayo, Tulsa, Okla.
Oct. 23-27—AIEE, Fall General Meeting, Skirvin Hotel and Skirvin Tower Hotel, Oklahoma City, Okla.
Nov. 9-10—SAE, Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.
Nov. 13-16—API, Annual Meeting, Biltmore, Hotel and Ambassador Hotel, Los Angeles, Calif.

1951

May 28-June 6 — World Petroleum Congress, The Netherlands, The Hague.

NOMADS MEET

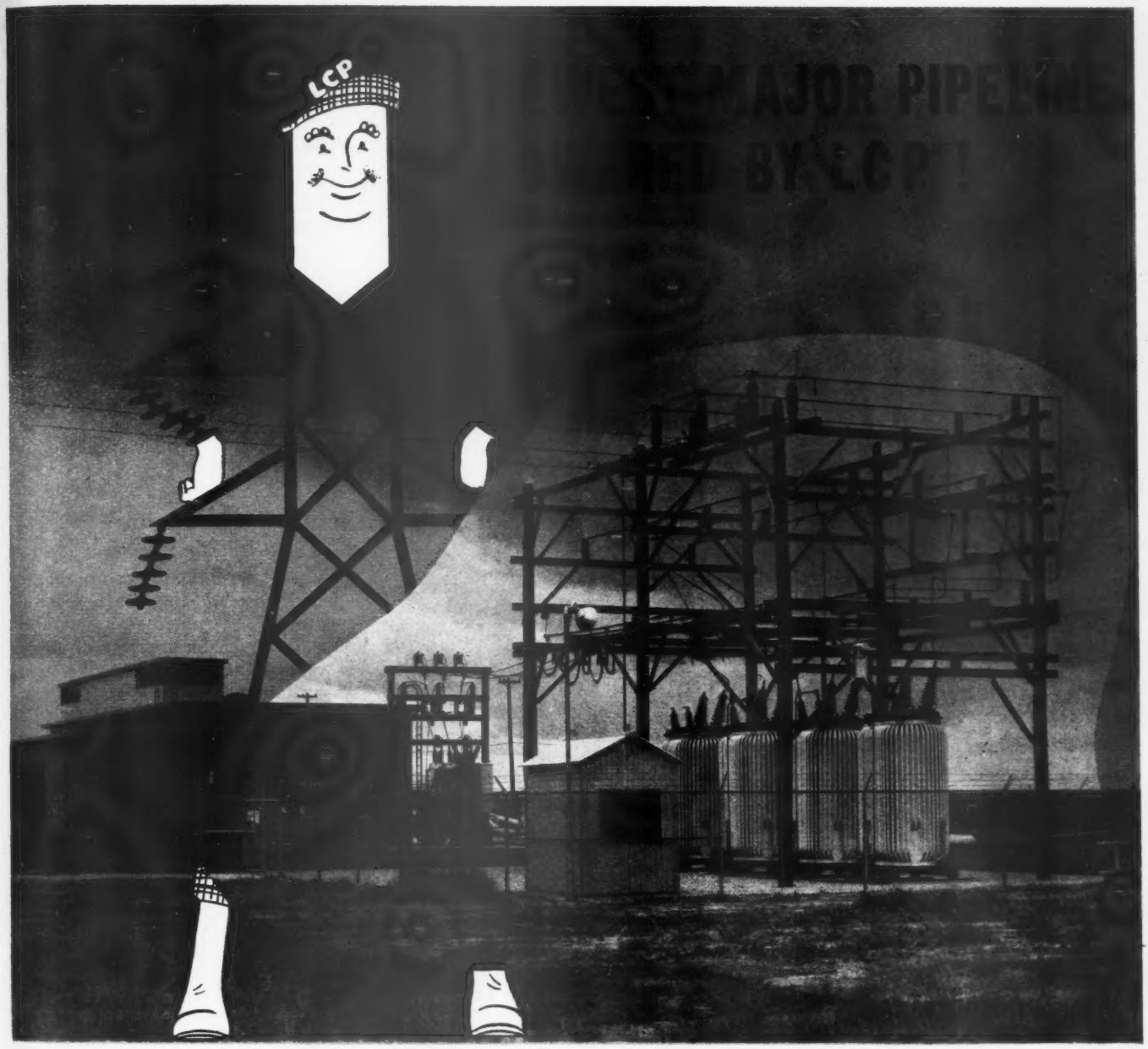
New York, N. Y., Chapter, First Monday of the Month, Louis Sherry's, New York, N. Y. Sec. Russ V. McIntire, 11 West 42nd Street, New York 18, New York.

Houston Chapter, Second Monday of the Month, Ye Ole College Inn, Houston, Texas. Sec. Harry E. Estes, P. O. Box 9321, Houston 11, Texas.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Sec. John W. Rife, 5905 Pacific Blvd., Huntington Park, Calif.

Tulsa Chapter, Third Wednesday of the Month, Hotel Tulsa, Tulsa, Okla. Sec. G. W. Davidson, Jr., Box 1188, Tulsa, Okla.

Dallas Chapter, Dallas, Texas, First Monday of the month. Sec. C. J. Berlin, P. O. Box 2968, Dallas, Texas.



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LETTERS
to the Editors

Pumping Possibilities

To The Petroleum Engineer:

Can you give me the answers to the following questions:

1. Would it be practicable to pump Bunker "C" fuel oil through a pipe line 100 miles long, which rises 9000 ft in that distance? The oil in question has a specific gravity of 0.958 at 60 F and viscosities of 8630 SSU at 80 F and 1800 SSU at 120 F.

2. What is the highest pumping temperature that could be used with the oil mentioned?

J. P. Manning, Jr.

South Norwalk,
Connecticut.

Editor's Note: *1. Bunker "C" fuel oil having a viscosity of 1800 SSU at 120 F could readily be pumped through a pipe line 100 miles long having a rise of 9000 ft. Oil having a viscosity of 8630 SSU at 80 F, however, could be pumped only if heaters were used along the line. The spacing of the heaters would depend on climate. In an average climate, such as Texas for instance, the spacing should be 15 to 18 miles. In colder climates the spacing, of course, would have to be shorter.*

2. Not to exceed 150 F.

Pipe Line Construction

To The Petroleum Engineer:

I wish to thank you for furnishing us with advanced information regarding new pipe line construction. This material is most helpful to us in planning our production and sales programs. We want you to know how much we appreciate this help and trust that you will continue to furnish information in the future.

R. W. Capaul,

Glass Fibers Inc.,
Waterville, Ohio.

Tables in Book Form

To The Petroleum Engineer:

We are deeply impressed in reading "The Petroleum Engineer's Continuous tables" presented every month in The Petroleum Engineer Journal, as it is very useful and instructive to us. Unfortunately, the issues in our refinery library are incomplete.

We wonder whether the Tables are available in a complete booklet form in your stock, and how we can get it. Shall you tell us in the return mail we will arrange the money order.

Dzung-Tsang Lee,

Kaohsiung Refinery,
Chinese Petroleum Corporation,
Kaohsiung, Taiwan.

Editor's Note: *The book of Continuous Tables is out of print but publication is planned for the future.*

First Gas Well

The first natural gas well drilled in this country was in 1821 at Fredonia, New York, antedating the first railroads built by about three years. Today 35 states are served with natural gas. Proposed new natural gas transmission lines to New England and to the South Atlantic Seaboard, when completed, will leave less than a half-dozen states in the nation, not served by natural gas. One hundred twenty-eight years ago, the population of the United States was about ten million. Today the natural gas industry serves about 12,250,000 customers, about 22.5 per cent more than the nation's population when the first gas well was drilled.

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THE Petroleum Engineer

MARCH
1950

Possibilities for Production of Liquid Fuels From Shale, Natural Gas, and Coal

Synthetics today would crowd an already saturated market but long term policy should be determined

PAUL D. TORREY*

PART 1

THE shortages of petroleum products that developed during World War II, the progressive increase in consumption that has developed in postwar years, the indicated prospects for even greater future demand, and the increased needs of foreign countries, have created great interest in the availability of adequate supplies of oil for the ordinary and possible emergency requirements of the United States. The possibility that foreign reserves of petroleum may not always be available in the amount desired has encouraged attention to the production of liquid fuels synthesized from other natural resources as a supplement to oil products obtained from underground petroleum reservoirs.

Oil shale and coal have provided liquid fuel products in many parts of the world, less abundantly supplied with petroleum than the United States, for almost 100 years, and an extensive synthetic liquid fuel industry based on coal was developed in Europe, especially in Germany, just before World War II. It has been natural, therefore, that shale and coal resources should receive attention when consideration is given to possible sources of supplemental liquid fuel supply. Waste agricultural and forest products can be considered for limited production of synthetic liquid fuels, but the cost of gathering large volumes of these materials greatly limits their usefulness.

Although the prospects for discovering large new reserves of petroleum in the United States certainly are not being abandoned, and the possibilities for increasing production of petroleum from known reserves are generally recognized, the oil industry and the Federal Government have been directing increasing attention to the problem of synthetic liquid fuel production as an industrial opportunity, and as a national defense measure. Much of the present work on synthetic liquid fuels is being directed toward long range objectives, and is not regarded as an immediate panacea for all the problems of supply and demand that have vexed the oil industry in recent years.

The Federal Government's activities in evaluating the possibilities of synthetic liquid fuels were accelerated by the adoption of the O'Mahoney Synthetic Liquid Fuels Act of 1944. This act provided for a diversified program of laboratory and demonstration plant research over a period of five years. Because of delays resulting from war and postwar difficulties and the increased importance of the subject, the O'Mahoney Act was extended for three more years and the authorized appropriations were doubled by an Act of Congress approved March 15, 1948. This act will carry the work into the year 1952. As a related objective, it was provided that "not to exceed $1,000,000 of the amount authorized by this Act may be applied to a program of production research on secondary recovery from stripper oil fields and in refining processes."

Under the Act of 1944, the Office of Synthetic Liquid Fuels was established in the Bureau of Mines. Laboratories and demonstration plants were built in various localities to carry on the work. The oil shale research laboratory is at Laramie, Wyoming, and the oil shale mines and demonstration plant are near Rifle, Colorado. At Bruceton, Pennsylvania, near Pittsburgh, a general research and development laboratory has been built to carry forward projects for the utilization of coals in synthetic liquid fuel production and laboratories for work on the production of synthesis gas have been established at Morgantown, West Virginia. At Louisiana, Missouri, a war-time synthetic ammonia plant site was obtained and has been converted to demonstration-scale plants for production of synthetic liquid fuels from coal by the coal-hydrogenation and gas-synthesis processes.

Research by the Federal Govern-

*President, Lynes, Inc.

EXCLUSIVE

ment and by the oil industry in the production of synthetic liquid fuels antedates the present work being conducted by the Bureau of Mines about 30 years. The Bureau started work on oil shale as early as 1916, and operated an experimental plant near Rifle, Colorado, during the period from 1925 to 1929. In 1927 it began a program of laboratory research on the chemical reactions involved in the production of alcohols and hydrocarbons from carbon monoxide and hydrogen, and in 1936 it took up experimental work on the liquefaction of coal. About 20 years ago the Standard Oil Company of New Jersey undertook a study of methods for the hydrogenation of coal and crude petroleum, and subsequently gave considerable attention to hydrocarbon synthesis for the production of motor fuel from natural gas and coal. This work was interrupted during World War II, but shortly thereafter was resumed on a large scale and now includes research on the production of oil from shale. In 1938 Stanolind Oil and Gas Company became actively interested in the possibilities for converting natural gas to gasoline, and began to acquire gas reserves in the Hugoton field, of western Kansas, to supply a synthetic liquid fuel plant.

Paralleling the more recent pioneering laboratory research and pilot-plant operations, and of significant importance has been the commencement of construction of a plant for the manufacture on a commercial scale of gasoline and other products from natural gas by Carthage Hydrocol, Inc., in south Texas. The construction of another plant of similar size by Stanolind Oil and Gas Company in western Kansas has been discontinued on account of high construction cost, which is reported to have more than doubled since the work was initiated in 1946. Each of these plants has been designed to produce around 7500 bbl of liquid fuels per day at costs that it has been hoped will be competitive with fuels refined from crude petroleum.

It seems reasonable to assume that more attention will be given to the development of substitutes for petroleum products as demands increase and as the finding of additional supplies of petroleum in the United States becomes more difficult. It can be emphasized, however, that the interest that has been developed recently by the petroleum industry in the production of synthetic liquid fuels is not based, necessarily, on fears of an immediately impending oil shortage. Rather, the trend of industrial research and planning has been directed to the utilization of natural gas for which profitable fuel-gas markets may not be immediately available, and to perfect processes that will ultimately be adaptable to the conversion of coal or lignite to liquid fuels at such time in the future when there may be an actual scarcity of petroleum in the United States. Much of the research now in progress is directed not only toward future supplies of liquid fuels for civilian use but also toward the guarantee of a domestic fuel supply adequate for any emergency that may develop. For these purposes, the experimental work that has been undertaken by the Federal Government, and the research and commercial work being carried on by industry have received very general commendation.

Under present relationships of fuel prices and production costs it appears unlikely that synthetic liquid fuel plants can be competitive with a great part of the oil now produced in the United States unless the synthetic plants are subsidized heavily by the government or unless important new discoveries are made in synthetic fuel technology. It can be foreseen, however, that some point could be reached in the future where both primary and secondary oil production in deep fields and in thin reservoirs will not be profitable because of competition from liquid fuels produced from alternative resources such as oil shale, natural gas, or coal. This predictable competition justifies a review of the major possibilities for the production of synthetic liquid fuels.

In contrast with the limited proved reserves in developed oil fields, supplies of shale and coal can provide a backlog of reserves for continued exploitation and development on a large scale for a very long period, and certainly up to the time when scientists encourage the belief that atomic energy may be generally available for the power requirements of the nation.

Secondary recovery operations have one common relation to the construction of synthetic liquid fuel plants in that they both will be initiated at times of reduced primary supply and of rising prices for crude oil. To this extent they are less competitive with each other than they are, for instance, with primary production. An abundance of cheap primary oil production would certainly be discouraging to extensive application of secondary methods in deep fields and in thin reservoirs, and, likewise, and for the same reasons, to the construction of extensive synthetic liquid fuel plants.

Oil Manufactured From Shale

Origin of Shale Oil. Shale oil is a waxy, highly unsaturated mixture of liquid hydrocarbon compounds with an appreciable nitrogen and sulfur content. Shale oil is the product of thermal decomposition of organic matter known as kerogen, which occurs in a wide variety of sedimentary rocks, and distinguishes oil shales from other rocks of similar origin and lithology. Kerogen is believed to be derived from the remains of primitive aquatic plants and animals, and consists largely of structureless, amorphous material that is insoluble in ordinary petroleum solvents, such as carbon tetrachloride and ether.

Occurrence of Oil Shale and Oil Reserves. Although the magnitude of oil shale deposits in various parts of the United States has been recognized for many years, the abundance of crude petroleum and the remote location of the more prolific shale reserves have discouraged active exploitation, except for experimental purposes. Oil has been manufactured from shale in various parts of the earth for many decades, and in some countries has constituted a very important source of liquid fuel supply.

In the United States deposits of cannel shale and oil shale, which will yield in excess of 15 gal per ton, are known to exist in Pennsylvania, West Virginia, Indiana, Kentucky, Colorado, Utah, Wyoming, and Nevada. The cannel and oil shales of the Eastern states are generally much inferior in quality or in magnitude of reserves to the oil shales of the Colorado Plateau region. The estimated reserves of shale oil in the more important deposites are listed in Table 1, as follows:

TABLE 1. Estimated reserves of shale oil in the United States.
(From Bureau of Mines, Geological Survey, and Appendix 1 of Report II of the Federal Oil Conservation Board)

State	Millions of barrels
Pennsylvania	13.8
West Virginia	13.8
Indiana	7,680.0
Kentucky	10,978.6
Colorado	300,000.0
Utah	42,800.0
Wyoming	3,044.0
Nevada	6.0
Total	364,536.2

If it is assumed, as Winchester[1] has done, that 90 per cent of the Indiana and Kentucky deposits, which can be produced by surface excavation, and that 60 per cent of the shale in place in other states will be retorted, the reserve of recoverable shale oil in the United States still amounts to some 224 billion barrels, an amount approximately 10 times the present proved reserve of petroleum. Some such discount from the calculated values seems desirable to allow for

shale that it will not be practicable to mine, and because the quantities in the states possessing the smaller reserves are much less than some of the uncertainties of estimation for the states in which the larger reserves occur.

From Table 1 it is evident that the oil shale deposits of the Colorado Plateau region are of major importance in the United States, and that Colorado has deposits of great magnitude. The significant size and quality of the oil shale reserves of Colorado undoubtedly influenced the location of the Bureau of Mines experimental plant at Rifle.

The oil shales of Colorado, Wyoming, and Utah occur in the Green River formation of Eocene age. The Green River has a total thickness of about 3000 ft, of which up to 1300 ft in some areas is oil shale of varying grade. Deposits of oil shale, of variable thickness, are believed to occur in the Green River formation over an area of some 16,000 sq miles. In the area of the greatest oil shale thickness, where an average yield of 15.75 gallons of oil per ton of shale has been determined, a total shale oil content of one billion barrels per square mile has been estimated.[2] No other known locality possesses such a remarkable concentration of liquid fuel source material.

Mining Oil Shale. The experimental mining operations near Rifle, Colorado, being carried on by the Bureau of Mines, are restricted to one shale section, and consist of a selective underground mine where material of variable quality can be produced for retorting experiments, and an underground quarry, supported entirely by shale pillars, which has been developed to demonstrate low-cost oil shale mining on a commercial basis. At a production rate of 15,000 tons per day, it is believed that the shale can be mined underground at a cost below $0.60 per ton. With an average oil yield of 30 gal per ton from the superior shale that is being produced, the mining cost will be less than $0.85 per barrel of oil recovered.

A shale oil recovery plant will use approximately 1.5 tons of 30 gal per ton shale for the production of one barrel of crude shale oil. This will amount to nearly 200,000,000 tons of shale, requiring about 75 per cent of the shale in two square miles of a 70 ft bed, to supply a plant producing 10,000 bbl of shale oil per day for a period of 35 years. The location of adequate reserves of shale for numerous plants of this capacity will offer no difficulty. The greatest reserves of shale, however, are situated in a rough, mountainous terrain, frequently at elevations of from 7000 to 8000 ft, so the plant sites must be selected with great care to insure efficient and economical development and operation.

Processing Oil Shale. At Rifle, the shale is mined, crushed to the desired size, and blended to provide the quality desired for particular retorting experiments. In the earlier work it was heated in retorts of batch types, which minimized the formation and removal of coke and sinter, and, therefore, offered advantages in the initial tests. Improvements over the batch system of retorting now seem possible for more extensive operations by the use of equipment such as the Socony-Vacuum continuous process,[3] the "Fluidized-Solid Method"[4] or the gas-flow process currently being operated by the Bureau of Mines.[5] The fluidized-solid method is a recent technique developed by Standard Oil Development Company, as a result of experience in the catalytic cracking of crude petroleum. A pilot plant employing this method was constructed during World War II, and was tested on Australian shale of high yield. Subsequently, Colorado shale was retorted successfully on a small scale. Larger scale tests of the method are being conducted by Standard Oil Development Company with the cooperation of the Bureau of Mines.

Quality of Product. The shale oil produced at the experimental plant at Rifle is a black, viscous liquid, with a high pour point, a high content of unsaturated hydrocarbons, and a substantial quantity of compounds containing nitrogen and sulfur. In commenting on the quality of the shale oil produced by present techniques, Lankford and Guthrie[6] have observed that the fractions obtained from straight distillation of shale oil are not of good quality. The straight-run gasoline has an octane rating below 60, is high in ring-type sulfur, tar acids, and tar bases; is gum-forming and has an extremely poor color stability. It is also deficient in the light ends required for volatility in motor fuel. The straight-run diesel-oil-fraction is of marginal quality having a low cetane rating, a high pour point, and a high carbon residue. Kerosine meeting the usual requirements cannot be made by the straight distillation of shale oil. The crude shale oil or residuum from topped shale oil is satisfactory for boiler fuel, though the latter has high viscosity and pour point. At present, asphalt or road oils of suitable quality have not been prepared from shale oil.

From the foregoing it will be evident that the refining of shale oil into usable products presents unusual difficulties. Shale oil is not a virgin stock in the usual sense of the term, but is considered to be a cracked product when it emerges from the parent rock in the retort. For this reason many refining problems are encountered in the processing of shale oil that are not inherent to petroleum. By complicated and expensive processes it is physically possible to produce high quality motor fuel and diesel-oil from shale oil. but the best present opportunities for the utilization of shale oil is believed to be for the production of various types of burning oils.

Some form of catalytic cracking, which might be employed in connection with the fluidized-solids technique of shale oil manufacture, offers possibilities for improved refined products. Also, since shale oil is highly unsaturated, consideration is being given to the possibility of either full or partial hydrogenation, even though the equipment and processing costs are relatively high. It is recognized that the hydrogenated shale oil may not be suitable for direct use, and may have to be considered as a feed stock that will require further conversion treatment, at an added cost, before products conforming to the ordinary standards of liquid fuels produced from petroleum will be obtained.

Costs and Possible Future Utilization of Shale Oil in the United States. From the incompleted work of the Bureau of Mines (1949), it is indicated that crude shale oil cannot be produced on a large scale for less than $2.00 per barrel. Estimates made in 1948, on the basis of Rifle operations, indicated that a viscosity broken shale oil might be produced by a continuous process at a cost of around $2.20 per barrel, and that this oil could be delivered to refineries in southern California by pipe line at a total cost of about $2.35 per barrel.

It should be emphasized that the shale oil produced at these estimated costs would not compare favorably in quality with crude petroleum that can be produced in many oil fields at a substantially lower cost. Furthermore, the isolated location and scarcity of water where the most prolific deposits of oil shale occur may limit their large scale utilization or increase the cost of production materially above the figures presented above.

The facts now available lead to the conclusion that fuel oils, suitable for ships or utility plants, may be produced from shale oil by a rather simple refining process, but complicated and probably quite costly processes must be developed for the production

of distillate fuel oil, diesel fuel, and gasoline of the quality obtainable from ordinary crude petroleum. The problem, therefore, of profitable utilization of shale oil is formidable. With tremendous deposits of oil shale available, however, there is certainly every reason to believe that continued attention will be given to the technological and economic problems connected with the production and utilization of shale oil, as it may be needed to supplement liquid fuel supply in the United States.

Synthetic Fuels From Natural Gas

Over 10 years ago Finch and Cattell,[6] in considering the possibilities of research on utilization of natural gas, stated: "Natural gas is one of the most easily used high-energy forms of fuel, and where it occurs with petroleum it serves an all-important role in lifting oil to the surface. Use of gas in recovering oil and as fuel, and the benefits and savings that may be derived by return of excess gas to the producing formations, should have first consideration, but conditions arise that lead to production of gas in excess of quantities that can be utilized as fuel, stored, or recycled, and use of such gas for conversion to synthetic products is a true conservation measure. In some instances it may be possible to make products from natural gas—especially from its heavier constituents — that have intrinsic or social values far surpassing those of the gas from which they are produced."

The Fischer-Tropsch Synthesis. The commercial development of methods for the conversion of natural gas to liquid fuels, now in progress in the United States, is based on a process of combination of hydrogen and carbon monoxide that was invented by two German chemists, Frantz Fischer and Hans Tropsch. Fischer and Tropsch discovered that alcohols and other oxygenated compounds, and some hydrocarbons were produced when water gas was passed at a high pressure and a high temperature through a catalyst consisting of iron particles impregnated with an alkali. Later they found that products consisting mainly of hydrocarbons could be obtained by passing the gas at lower pressures and temperatures through catalysts composed of iron, cobalt, nickel, and various other metals supported on kieselguhr and similar carriers. During World War II, nine Fischer-Tropsch plants were operated in Germany, and in 1943 their combined production was about 11,500 bbl of synthetic oil a day. Coal was used as the basic raw material for the production of synthesis gas in these plants, and a cobalt-thoria-magnesia-kieselguhr catalyst was used in converting the synthesis gas to synthetic oils. This process yielded chiefly straight chain, saturated compounds. The resulting diesel fuel had superior qualities, but the gasoline produced was not of high quality.

Early research in the United States on the possibilities for the manufacture of synthetic fuels from various raw materials indicated that cheap and abundant natural gas was a far more promising source of carbon and hydrogen for the gas synthesis process than coal. As a result of continued research in this country, a variety of synthetic processes have been developed that embody the basic principles of hydrogen and carbon monoxide combination developed by Fischer and Tropsch, but that, otherwise, bear little similarity to the earlier German operations. American research has favored iron catalysts, which produce more oxygenated compounds, but at the same time hydrocarbons of better quality than those obtained from the use of the more complex catalysts developed in Germany. The fluid catalyst technique, which has been applied so successfully for the cracking of heavy hydrocarbon molecules, and which yields from 85 to 90 per cent of gasoline, has been an important factor in the development of the processes used in American experiments and in American plants. As a result, the production of gasoline possessing excellent qualities is anticipated in the American plants, in contrast to the inferior gasoline produced by the original German process, which actually retarded the growth of the Fischer-Tropsch industry in Germany. Furthermore, American research has developed converters with outputs in excess of 1000 bbl of synthetic oil per day in comparison to the German converters, which produced only about 18 bbl per day from each unit.

In the various synthesis processes being developed in the United States, large quantities of cheap oxygen are required for the production of the synthesis gas. Also, the removal of the sulfur compounds from the raw gas is essential, which will make the production of synthetic fuels from sour gas much more costly if not entirely impractical under existing economic conditions.

Quality of Products. The products derived from the various American synthesis gas processes are principally hydrocarbons and from 5 to 15 per cent of oxygenated compounds consisting of organic acids, higher alcohols, and ketones that separate in water solution. The anti-knock properties of the straight-run gasoline are not good; however, the use of the fluidized catalyst technique enables the production of gasoline having a highly olefinic content, which can be refined to a high grade motor fuel, or the straight-run gasoline may be blended with benzol or alcohol, or treated with tetraethyl lead to improve its quality. Diesel fuel of excellent quality can be produced by the gas synthesis process.

Costs and Possible Production in the United States. Oberfell[7] in March, 1946, and Power[8] in February, 1947, estimated that gasoline might be produced from natural gas by the synthesis process at a total cost of $0.088 per gallon. This figure includes normal overhead, 10 per cent depreciation per year, and natural gas at $0.05 per M cu ft. Under these conditions, the belief has been expressed that the synthetic fuels from natural gas will be competitive with refined products from petroleum with a crude price of $1.75 to $2.00 per barrel. If the gas should be worth $0.10 per M cu ft the cost of synthetic gasoline has been estimated to be $0.118 per gallon.

Much more recently, the figures of Oberfell[7] and Power[8] have received confirmation from Keith[9], who has stated that gasoline can be produced from natural gas by the synthesis process at a cost of $0.0833 per gallon with gas worth $0.083 per M cu ft. If the price of gas is doubled the cost of gasoline, in his opinion, will be increased by only $0.0166. These figures allow credit for the sale of chemical byproducts, for 10 per cent amortization, and a 10 per cent return on 50 per cent of the invested capital and 4 per cent return on the remainder, and probably apply only to the Carthage Hydrocol plant, at Brownsville, Texas, which is understood to have received large government loans.

Using a slightly different approach, Murphree[10] estimated in April 1948, when costs were somewhat higher than at the time when Oberfell and Power were making their calculations, that the approximate cost of high octane synthetic gasoline manufactured from natural gas at $0.10 per M cu ft would be $0.128 per gallon. (See Table 3 in Part 2.)

The proved natural gas reserves of the United States at the end of 1948 have been estimated by the American Gas Association to amount to almost 174 trillion cubic feet. Assuming a production of four gallons of liquid fuel from one thousand cubic feet of gas, a figure that appears to be reasonably reliable in the light of pres-

Humble Company Develops Sulfide Corrosion Control

Humble Oil and Refining Company will soon place on the market a new inhibitor for sulfide corrosion in producing oil wells. Trade name for Humble's newly developed product will be "Corexit."

The serious problem of corrosion of tubing, rods, pump parts, wellhead fittings, and flow lines of oil wells producing fluids containing hydrogen sulfide has long bothered oilmen. There are now three methods of attempting to control corrosion: Use of protective coatings, alloy steels, and chemical inhibitors.

Chemical inhibitors have come into general use only recently. Corexit incorporates the following properties: It is a free-flowing liquid; has no objectionable odor; is non-toxic; and is available at reasonable cost.

Field trials of various inhibitors were made for several years in sour crude areas of West Texas. In these trials an initial amount of the inhibitor, usually five gallons, was batched into the annulus and by a simple piping arrangement the inhibitor and well fluids were circulated for 24 hr in the closed system consisting of annulus and tubing. Continuous injection by chemical feeder or daily batch injection by gravity-feed lubricator was then started.

It is likely that there are many moderately corrosive wells that can be satisfactorialy treated at low cost with resultant net savings of several hundred dollars per well per year, Humble researchers believe. They also feel that some wells, which would otherwise have to be shut in or abandoned because of material failures could, by the use of the proper chemical inhibitor, be profitably produced.

ent developments, the proved gas reserves of the country are estimated to be equivalent to about 16.5 billion barrels of liquid fuels.

The prospects for obtaining more than a small part of the equivalent liquid fuel from proved natural gas reserves are rather remote. A gas synthesis plant must have large capacity and must be assured a long and uninterrupted life to offer attractive investment possibilities. A dependable reserve of from 400 to 500 billion cubic feet, which can be produced at a uniform rate over many years and at moderate cost, appears to be the minimum amount that will be required to supply a profitable synthetic liquid fuel plant.

A synthetic liquid fuel plant with a capacity of 10,000 bbl per day will require a reserve of approximately one trillion cubic feet of gas to insure an operating life of 25 years. Gas reserves of such magnitude are known in only 10 states of the United States, and it is certain that a majority of the larger gas reserves are committed for uses that have already been established. Consequently, any large natural gas-synthesis development in this country will have to depend chiefly on new discoveries for a source of raw material, excepting certain reserves in western Kansas, and in parts of Louisiana and Texas.

Small, scattered reserves of gas, reserves of gas that cannot be produced at a uniform rate on account of restrictions on oil production, or low-pressure gas that is expensive to gather and compress are not suitable sources of supply for synthetic fuel plants. Because of these limitations, it is doubtful whether more than 100,000,000 bbl of synthetic liquid fuels can be made per year in the United States from all available gas reserves. R. A. Cattell[11] has expressed the opinion that the synthetic liquid fuel producible in the future from the present available reserves of natural gas, which might be used for that purpose, is in the order of 3 billion barrels. A. L. Solliday[12] has stated that the opportunities for natural gas synthesis plants are so limited that probably less than 20 will ever be built in the United States even if the need for a supplemental liquid fuel supply should become urgent. The justification for at least part of these plants is that eventually they might be converted from natural gas to the use of coal as a source of raw material.

It will be evident, from the foregoing discussion, that the complete utilization of all surplus natural and casing-head gas for the manufacture of synthetic liquid fuels is not feasible, and, as a result, the possibilities for competition from this source with crude petroleum is virtually nonexistent. The fact that liquid fuels possibly can be made from natural gas at a profit under certain favorable economic conditions will certainly tend to discourage the unrestricted waste of gas that has prevailed in certain fields in the past. If large gas reserves should be discovered that do not have an immediate profitable market, the utilization of the gas for the manufacture of synthetic liquid fuels undoubtedly will receive consideration before any commitment is made for other disposition of the gas, particularly at distress prices.

Synthetic Liquid Fuels From Coal

As mentioned previously, the synthesis gas for the original Fischer-Tropsch liquid fuel plants in Germany was derived from coal and lignite. Known coal reserves in the United States, when considered in the form of fuel values, are many times larger than the combined reserves of petrolum and natural gas. Consquently, consideration must be given to the proved possibilities for the utilization of coal in all long-range planning for production of synthetic liquid fuels, and to the effect that fuels so produced might have on the future production of petroleum.

Liquid fuels can be produced from coal by the Fischer-Tropsch process of synthesis of coal gases, by coal carbonization, and by coal hydrogenation.

Eventually, the greatest synthetic fuel activity will undoubtedly be based on the utilization of coal, for the nation's coal reserves provide a substantial foundation for a large liquid fuel industry.

Coal Characteristics Desirable for Synthetic Liquid Fuel Production. Characteristics of coals that will have a bearing on their use for either the gas synthesis or the hydrogenation process are similar to some of the requirements for suitable coking coal. They include ash and moisture content, storage properties, and uniformity.

Although high-ash coal can be gasified, it can almost always be concluded that low-ash coal can be used to greater advantage in almost any process in which coal is a basic raw material. Consequently, for the production of synthetic liquid fuels the washing of the coal may be required. High surface moisture, produced by washing, can result in difficulties in the handling of pulverized coal, and, in any event, the moisture on the coal particles, if not removed by prior drying, will require additional heat for evaporation during processing.

As synthetic liquid fuel plants will probably be designed to operate continuously, substantial reserves of coal must be maintained, which will require large storage capacity. Coals that weather rapidly, likely will require special storage facilities which will tend to increase both development and operating costs.

Uniformity of the coal, unquestionably, will be a most important characteristic in the production of synthetic

liquid fuels because both the gas synthesis and the hydrogenation processes are rather delicately balanced operations that will require a constant feed of uniform quality solid fuel. Variations in ash, sulfur content, ash-softening temperature, and coking properties can affect the action of the catalysts, and of operating conditions, such as purification of synthesis gas, temperature of gasification, and control of coking if the coal is to be gasified in the fluidized state.

For the hydrogenation process, generally the lower rank coals are more readily and more completely liquified than the higher ranking coals. This tends to offset the disadvantage of high moisture content of the low rank coals. The yields for various suitable coals in the process are roughly proportional to the heating value.

Production of Synthesis Gas from Coal. Several methods have been developed whereby synthesis gas may be produced from coke, coke-oven gas, lignite, or from the complete gasification of coal or coke with steam and oxygen. The end product of all of these processes is a mixture of gases that consist chiefly of hydrogen and carbon monoxide, along with more limited quantities of methane, nitrogen, and carbon dioxide. The synthesis gas, after purification, is converted into liquid products in a manner essentially the same as that described previously for the conversion of natural gas. In consequence, all progress made in the development of the Fischer-Tropsch reaction for the use of natural gas in the production of synthetic liquid fuels may find future application in the utilization of coal for this purpose.

The chief obstacle to low cost production of liquid fuels from coal by the gas synthesis process lies in the fact that the production of the synthesis gas by presently known methods is an intermittent or batch process. Research directed toward the development of a less expensive continuous process for the production of synthesis gas is now being conducted by the Pittsburgh Consolidated Coal Company and Standard Oil Development Company at their experimental plant in western Pennsylvania, and by the Bureau of Mines at Morgantown, West Virginia, and at Pittsburgh and Bruceton, Pennsylvania. Processes so developed will be tested by the Bureau of Mines on a demonstration-plant scale at Louisiana, Missouri. Other research is being directed to the development of an efficient underground process for the gasification of coal, which largely would eliminate mining costs. The development of such a process would remove one of the principal obstacles to the profitable production of liquid fuels from coal, and if it can be proved to be feasible, the process should permit the utilization of coal veins that might be difficult or unprofitable to mine in the conventional manner.

Coal Carbonization. Fieldner[13] has estimated that from 20 to 35 gal of tar oil from which can be obtained from 4 to 7 gal of motor fuel can be produced from one ton of high volatile bituminous coal by a simple, low-temperature carbonization process, somewhat similar to coking. Low-temperature carbonization is primarily a process designed to produce a solid, smokeless fuel, in which liquid fuels and gas are obtained as byproducts. The motor fuel is not produced directly, but results from the cracking of the tar, one of the primary products of the process.

In point of volume, the production of liquid fuels from the carbonization of coal is greatly inferior to the production obtained by the use of the gas synthesis process. In addition, the tar produced by the carbonization process contains about 20 per cent by volume of organic acids and other chemicals.

Hydrogenation. Solid fuels, such as lignites and coals, may be transformed into liquid fuels by a variety of reactions occurring simultaneously and to varying extents in the general process of hydrogenation, invented and patented in Germany in 1914 by F. Bergius, by which atoms of solid carbon are combined with atoms of gaseous hydrogen to form liquid hydrocarbon molecules. Catalysts, such as the oxides or sulfides of molydenum, tungsten, and chromium, improve tremendously the velocity of the reaction, and certain catalysts will accelerate the cracking of heavy molecules to the more volatile hydrocarbons of lower molecular weight that are required for motor fuel. Hydrogenation processes can either be in the liquid phase, in which some form of highly pulverized coal mixed with heavy oil to form a paste is employed, or in gas phase reactions where the molecular weight of light hydrocarbons is increased.

The experimental coal hydrogenation plant of the Bureau of Mines, at Louisiana, Missouri, was completed during the early part of the current year (1949), and was placed in operation in May. This plant is designed to produce about 200 bbl of gasoline per day, and it is expected to provide cost data that can be interpreted and extrapolated to give an indication of what costs might be in a commercial scale plant. Bureau of Mines experiments in the hydrogenation of coal have included a wide variety of raw material, including peat, brown coal, lignite, subbituminous coal, and bituminous coal. All of these materials yield large amounts of hydrocarbon liquids under optimum conditions, but the use of subbituminous coal, because of its great abundance and lesser desirability for direct combustion purposes, will probably be favored.

Motor fuel of excellent quality, with a substantial percentage of napthenic and aromatic hydrocarbons, can be produced by the high pressure hydrogenation of coal, and it is noteworthy that the Germans made practically all of their wartime aviation gasoline by the hydrogenation of coal and tar, even though some 70 per cent of their total oil supply was petroleum, largely from high quality sources in Polish and Roumanian fields. The recovery of gasoline by hydrogenation increases from the lower ranks of coal to the higher ranks because of the higher moisture content of the lower ranks. An average yield of two barrels of gasoline per ton of good bituminous coal is indicated.

In contrast to the product distribution of the gas synthesis plants now under construction and contemplated in the United States, which consist of about 90 per cent gasoline and liquefied hydrocarbon gases, the coal hydrogenation process is extremely flexible, and can readily produce a high percentage of aviation gasoline, motor gasoline, diesel fuel, jet fuel, or fuel oil, as desired. This factor would enhance the value of coal hydrogenation plants for national defense, for, in an emergency, the demand for any particular product, such as aviation gasoline or jet fuel, which, undoubtedly, would increase greatly over ordinary domestic consumption, could be supplied to the limit of the capacity of the plant, by an adjustment of the processing schedule.

Important research is now in progress for the development of a method to hydrogenate dry coal without mixing it with oil to form a paste. If this work proves to be successful, the equipment for producing and handling the paste will be eliminated, and there will be no further need for the recycling of large amounts of oil around through the plant. Extensive studies, also, are being made in a search for catalysts which will allow operation at relatively low pressure for the production of fuel oil. It will be evident that favorable results from these studies could mean major changes in the economics of hydrogenation.

The second and concluding part will be published soon.

Six-Year Plan for Polish Oil Industry*

Authorities in various phases of the petroleum industry discuss present and future of nationalized operation

DRILLING

Prof. Eng. Jan Czastka

One of the points in execution of our six-year plan must be the directed effort for the marked increase in the rate of drilling. As a sample, such efforts crowned by splendid results may serve the drilling program of USSR. If in 1930 the average advance for rotary was 258 ft then in 1937 the rate was 1630 ft per drill, per month; that means that in 7 years USSR achieved a 5-times increase in the number of drilled feet, per drill, per month. Though later, and during the second war, the progress was slightly reduced (in 1938-1390 ft, 1939-1320 ft, 1940-1345 ft, 1941-1360 ft), nevertheless, the advancement was much above the rate of drilling in 1930.

In the US the average rate of rotary drilling was in 1943-1944 (N. N. Kalmykow) around 2580 ft per drill, per month. The projected achievement for 1955, about 600 ft per month, per drill, remains far behind the two technically advanced countries, that is, US and USSR, and it is not yet known how far those countries will advance by 1955. As far as the analysis of cable drilling goes this technique can be compared only with the US where this method is in some use in the Western oil fields. In USSR this technique is no more in use. Same N. N. Kalmykow, referred to above, states that in US the average drilling rate in cable drilling is about 1300 ft per month, per drill. It is clear, that even in this field we are far behind; the projected rate for 1955 is 500 ft per drill-month.

Let's decide whether we can compare uncritically such data and the inevitable conclusion is, that this is not permissible. We have to take into account the peculiar working conditions in our fields. Here the first thing to consider is the difficult geological, tectonical, and lithological conditions, whereas in US or in USSR, those conditions are, generally, much more favorable. The existence of large structures of gentle dip, lack of intense folding on the flanks, absence of loose sediments, smaller volumes of bottom-waters in the opened fields, less changeable lithology of drilled horizons, form good conditions for speedy drilling.

Difficult geological, tectonical, and lithological conditions in our fields constitute some of the important and basic factors, precluding the progress of drilling at a rate commensurate with the above mentioned countries. Nevertheless, the geological conditions is the only factor in our fields over which we have no control.

At the same time, the rate of drilling is influenced by other factors, as for example:

1. The nature and shape of the drilling tool (bit-versus the rock-bit).
2. The composition of the bit and his thermal processing.
3. Number of falls per unit of time, or the height of fall of a bit (in cable drilling) and the relation to revolutions per minute in the rotary drilling.
4. Weight and the length of the drilling outfit in cable drilling and the rotary, the pressure of the bit on the bottom of the well.
5. The level of mud and the speed of removing the crushed material from the working face.
6. Type of the drilling equipment and its technical perfection.
7. The experience and organization of the drilling crew.
8. Organization of the work and supplies.

It is evident that all those points are related to the human factors. Through corresponding selection and coordination of all those factors, under an optimum of favorable conditions, we will be able to achieve a greater progress in drilling than to date. As far as material or constructive factors enter into play it is in our power to produce good drilling equipment.

It is in our power to build up a good working organization and arrange a proper supply of material. The selection of experienced and well organized crews of high practical "know-how" will work, under good circumstances, in the best working conditions. The outcome will be a higher drilling rate. The high stand of our drilling technique and the high qualifications of our drilling personnel will be able, partly to overcome our difficult geological conditions. We cannot assume that a Pennsylvanian drilling outfit, used in the US, is technically perfect machinery. The drilling outfit normalized by the Union of Polish Oil Engineers in Boryslaw (1929-1931) was a better technical tool than the usual Pennsylvanian outfit used in the US.

Completing our six-year plan, we have to pay great attention to all factors influencing the drilling progress. The possible discovery of new oil fields in Poland, at much greater depths, will require faster, cheaper, and better drilling technique. We should start also to study the possibilities of using the turbodrills or even electro-drills.

The problem of fast, cheap, and well organized drilling occupies the main place among the problems of our oil industry.

OIL PRODUCTION

Eng. J. Wojnar

W. Kulczycki, in his article "Rational Production of Oil in the Six-Year Plan," states that the popular opinion of a natural rate of decrease in oil production of 14 per cent is misleading. It is not correct, because that refers only to the initial stage of production, when the oil starts to flow from the wells, but not when the production is a regular one. The author in the same article gives the defini-

*Translated from *Nafta*, November, 1949.

1. N. I. Szacow—Oil well drilling, Gostoptechisdat, Moskwa-Leningrad 1947 (p. 685).
2. From the time of spudding a well till transfer to prod. dptm.
3. N. N. Kalmykow. The present standard of drilling technique in USSR. Ways of increasing the speed of drilling. Gostoptechisdat. Moskwa-Leningrad 1946.

tion for the natural rate of decline from an oil horizon and its relation to the total output of oil from the well. There is undoubtedly some misunderstanding, because in planning, we cannot link the production from the old wells with the production from the new ones.

It is common knowledge that the initial rate of decline depends on the nature of the beds and the conditions of production. For a proper understanding the production of old wells should be treated separately from the new ones. For a better understanding of the natural rate of decline, it is necessary to re-analyze the whole life-history of separate wells with graphical presentation of the productivity for each well.

It is possible to reconstruct from the graphs the picture of full production from separate fields; a group of such graphs will present the history of production from different pools and the natural rate of decline for the whole oil industry. In determining the natural rate of decline from the old wells, it is necessary to eliminate all the wells that, in the given time, enter into exploitation as the new ones, i.e., newly drilled wells and deepened wells, or the wells brought in by secondary methods, such as water flooding, gas lift, or shot wells. From the analyses of the Oil Institute for all our fields, it appears that the natural rate of decline is different for different pools; it varies from 1 per cent to 13 per cent and the average for all Polish fields gives 13.6 per cent. Fig. 1 presents a picture of decline for some of our fields. The same natural rate of decline for fields working on a gaslift or for shot wells, in the postwar period is, for all Poland, the same 13.6 per cent as the rate of decline for the old wells exploited in the normal way. Totally different are the conditions for new or deepened wells. The rate of decline is much higher and varies widely in the first year after drilling. It flattens considerably in the second year, and in the 3rd year approaches the normal rates of decline.

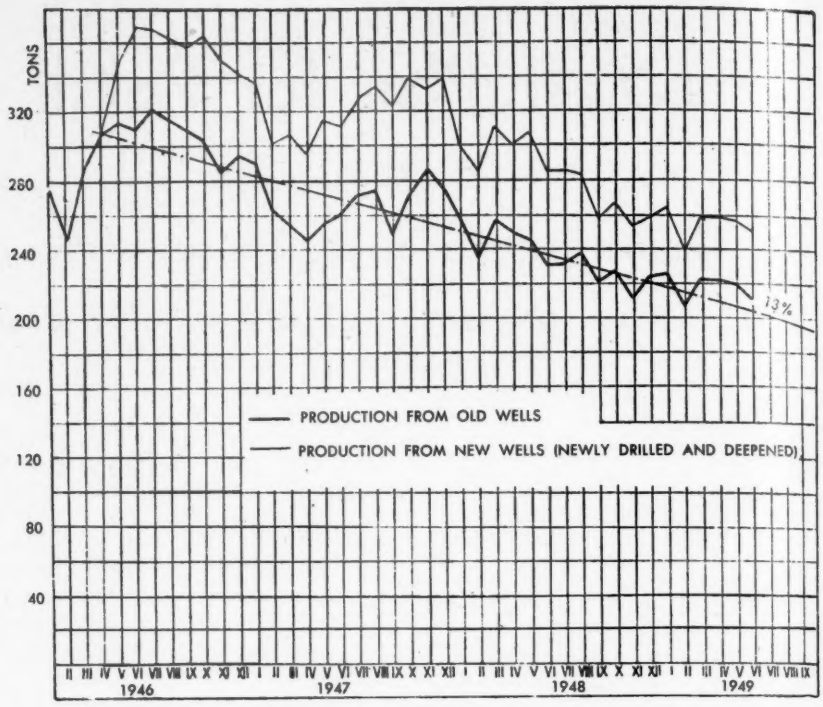

FIG. 1. Natural rate of decrease in a certain oil pool.

The average decline in production, from new and deepened wells, in 1946 is 45 per cent for the first, 31 per cent for the 2nd, and 13.6 per cent for the 3rd year of production. For the areas under consideration these rates of decline are important and depend on the initial productivity of the wells and the rate of drilling. It is impossible for the above stated reasons, to link the production from the old wells with the production from the new ones; the problems are completely different and for intelligent planning their separation is necessary. Fig. 2 shows, for example, the proper way in planning production for a particular oil pool, assuming for this pool, the original production starting in 1949 and the given natural rate of decline expressed in the shape of curves for the years 1950-55. Adding to this graph, the old production and the oil extracted by the use of secondary methods plus the newly obtained production the planned yearly output will be given. The necessary correc-

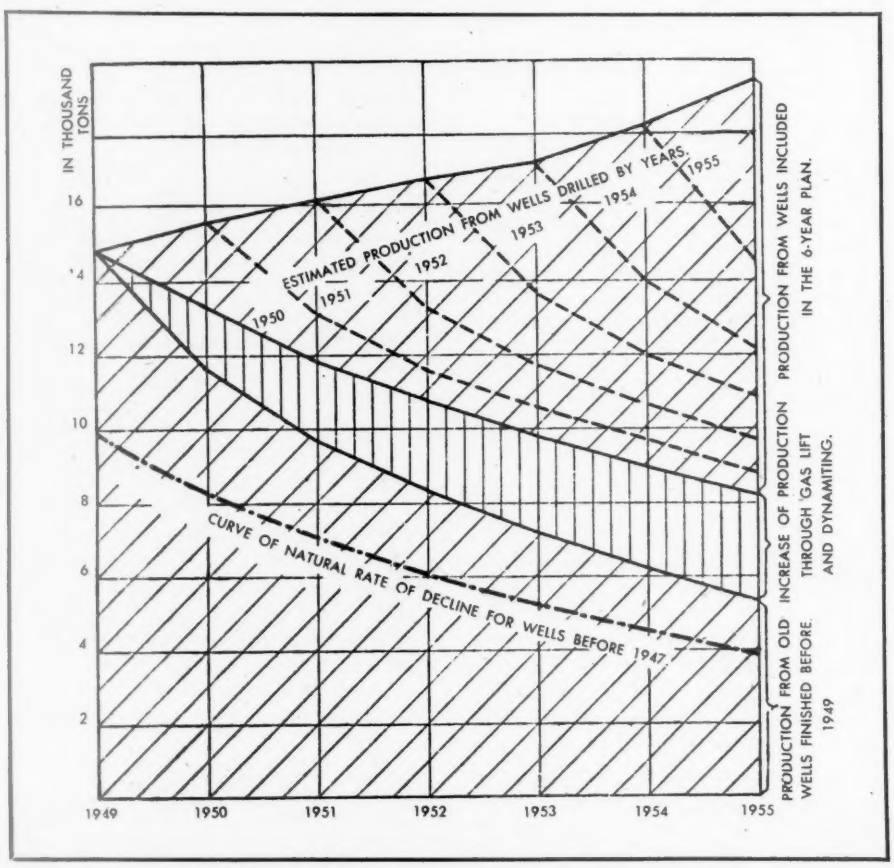

FIG. 2. Planned production for a certain oil field.

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tions for decline will be 45 per cent for the 1st, 31 per cent for the 2nd and 13.6 per cent for all consecutive years.

To introduce such planning it is necessary, of course, to have a detailed analysis of all pools from the points of view of their development, production of new wells, deepening of the old ones, and their original production. Certain indications on the productivity will be obtained from the production of neighboring wells and coefficient of productivity in tons of oil, per meters of depth in a given bed, can be established. The following table containing such coefficients for 1946-48 built up separately for new, "e," and deepened, "g," wells. Drilling coefficient in tons per linear meter.

These given coefficients may be useful for planning future production from deepened or rebuilt wells, but the numbers given should not be used in a way of averages, but separately, as the variations in coefficients are considerable. In general, it should be stated, that much better results are produced by the deepened wells and it only depends, whether in the 6-year period there will be a sufficient number of wells to deepen.

The highest coefficients for the indicated 3-year range belong to the Sanok district wells, and the lowest ones to the Gorlice. The coefficients are of relative value, because they refer to different depths; the average depth in Sanok is much greater than in Gorlice. For Sanok district it is about 2500 ft, for Krosno 2000 ft, and for Gorlice 1500 ft. It is well known, of course, that shallow depths are less expensive to drill than the deeper ones (per meter); moreover, in shallow horizons smaller amounts of oil make the well profitable. In planning for 1950-55 production those coefficients have been fully used; they are slightly higher than the indicators for 1946-48 and they will increase progressively. This possible increase is not taken into account yet.

The next question is the rate of drilling. In 1946-48 the rate of drilling increased from year to year about 30 per cent; the drilling rate for 1945-46 was much higher, but cannot be taken into consideration because of numerous additional drilling units. Thanks to the speedy increase of drilling rate, we increased our oil production. It was the time of reconstruction of the industry, destroyed during the war, and in the old Poland the average yearly increase of production, in the 3 years plan of reconstruction, was much greater than the projected increase for the next 6 years. In 1952-3 footage in relation to oil production should increase by only 8 per cent. In his book "Six Years' Plan of Development and Economical Reconstruction of Poland," H. Minc states that industrial production at the end of the 6-year period must increase from 85 per cent to 95 per cent in relation to production of 1949, which means that the global industrial production will be on the average 3 times greater than before the war or per capital of population 4 times greater.

In accordance with the basic principles of our industrialization, the highest tempo of increase in production is postulated for the basic industrial products with the exception of coal. Maximum tempo of increase is postulated for the chemical industry (290-300 per cent), same as for the metal and machine industries; the production of the latter in 1955 must be 2½ times as great as the production in 1949.

The amount of oil produced by the known pools, already in production, will depend on drilling. In accordance with the 6-year plan, the tempo of drilling will be slower than in the 3-year plan of reconstruction, and will increase by 20 per cent per year, forming in 1955 an increase of 120 per cent in relation to 1949, which is about 30 per cent greater than the average increase of industrial production in Poland. In oil production such planning seems to be less advantageous; the increase must be only 50 per cent but that apparently cannot be compared with any other industry, because in the oil industry we have to count with the steady natural rate of decline of production, for oil extracted from the earth.

At the same time the amount of produced oil depends on footage drilled and therefore to drilling must be paid the greatest attention. Deficit of liquid fuels in Poland suggests the increase of number of wells and footage in the same way as was planned for the chemical or metal industries. For the time being, due to the lack of credits, the number of drilled feet in 1955 will show only 120 per cent increase in relation to 1949. In relation to the prewar years, the footage level of 1948 will be achieved only in 1953 and in 1955 will be overtaken by only 50 per cent.

The question whether our petroliferous areas could be drilled faster should be thoroughly examined. We will have enough drilling outfits and tools and even more than necessary in the next few years and we will not be short of fully qualified technical personnel and labor. Lack of credits remain but should not be an obstruction in the development of our oil industry.

Oil remains a deficit basic material in Poland, without which the economic development of the country will be very difficult. It is a pity that the author in his article gives so little consideration to the most important factors in the oil industry: Footage and drilling progress.

NATURAL GAS

Eng. Marceli Karpinski

THE problem of supplying the cities by natural gas will be of great importance in the future and notwithstanding the present indifference toward this question, we must examine it in detail. Natural gas must be supplied to cities already lying close to the system of gas pipe lines belonging to the State Gas Trust or to those that are close to projected pipe lines. The number of places supplied presently by the pipe lines is small. Among these are Bielsk and Krakow whose plants receive the natural gas transformed into an industrially mixed gas. The same is true of Jaroslaw and Krosno, where the natural gas is combined with air and, finally, Jaslo, Gorlice, and a few other small localities.

For purposes of gasification of cities and utilization of natural gas for cars, etc., "The Natural Gas Trust" in the six-year plan projects the development of extended networks of pipe lines in the direction of Warsaw, through Radom; from Skarzysko to Kielce; from Sandomierz through Krasnik to Lublin (with a branch to Krasnostaw Chelm and Zamosc); from Skoczow to Cieszyn; from Bielsk to Zywiec, from Gorlice to Krynica, and from Nowy Sacz to Grzybow. The proposed pipe lines and those already in existence, will assure a gas supply for Kielce, Ostrowiec, Radom, Sandomierz, Skarzysko, and Wierzbnik in the district of Kielce.

In the Lublin district, Chelm, Krasnystaw, Lublin, and Zamosc; in the Silesian district the cities of Cieszyn, Dziedzice, and Skoczow; in the Krakow district Bochnia, Chrzanow, Krynica, Nowy Sacz, Oswiecim, Trzebinia, Wieliczka, and Zywiec; in the Rzeszow district, Debica, Mielec, Nisko, Przemysl, Rzeszow, Gorlice, Sanok, and Stalowa Wola are included in the project and, if necessary, the Warsaw district will embrace Pruszkow, Wlochy, Grojec, Zyrardow, and Grodzisk, as well as Warsaw itself.

The developments of the project

must follow this plan. Yet, before such large scale plan of gasification of cities can be started, there are many problems that should be solved in advance.

One of the first is whether the cities that do not have gas plants should use pure natural gas, as for instance, Jaslo; mixtures of natural gas with the air as in Tarnow, Krosno, Jaroslaw, or mixtures of natural with water gases.

Each approach has its advocates and opponents. For the use of pure natural gas the advantages are smaller diameter of pipes, smaller gasholders, and consequently a smaller investment; against such a solution are the absence of corresponding equipment for use of natural gas and certain restriction in the burning of natural gas. For the use of a mixture with air one advantage would be the easy change to existing gas lines for the local gas consumers; and a disadvantage, the danger of corrosion inside the pipe lines. Good burning conditions would suggest the use of a mixture of natural and water gases. In opposition, there is the higher investment and the operating expenses of generators and/or subsidiary installations to be considered. The absence of systematic observations precludes a formulation of any policy; the question is open and must be solved in the shortest possible time.

Another question is the working pressure of natural gas in the distribution system. It is known, that the amount of compression is a deciding factor in the selection of pipe diameters and consequently affects costs. The usual practice is to use 3 stages of compression. That of low pressure is about 300 mm water pile, the middle stage about 1000 mm of water, and the high stage is about 10,000 mm of water pile. Low pressure installations need pipes of large diameters and consequently involve high costs. Yet the delivered gas can be used directly without pressure reducing installations. Middle pressure requires pipes of smaller diameters; the price of pipes will be considerably lower than as for low-pressure lines. But the working pressure of the delivered gas is decidedly too high for direct use and must be reduced to lower stages. Such reducing installations could be placed at the entrance of the buildings or at the entrances to the apartments, at the central gas plant.

For high pressures, the diameter of pipes and costs are at their minimum, but the reducing installations, for safety reasons, must be outside the buildings. That leads usually to the building of reducing stations for large groups of buildings, which adds considerably to the costs. Such an additional factor forces the enlargement of the gas system with additional construction costs. The fact that direct connection of buildings with the high pressure system is undesirable, such systems can be used only for the gasification of large cities or for relatively long distance pipe lines.

In choosing between the low and middle pressure systems a compromise can be made by installing a middle pressure system and using low pressures while the number of consumers is relatively small during the initial period of operation. It is fairly well established that a gas network should be projected for 30 years, at the end of which period the line should be carrying a full load. For the first 10 years, the load would be approximatelv 25 per cent and for this period middle pressure system would be suitable. The advantage here is that the cost of line pipe is cut nearlv to half and the cost of building the system is reduced in proportion.

Another important feature of the middle pressure system is its flexibility for expansion. Because of the pressure reducers, which maintain a constant gas pressure at the consumers' end—independent of the pressure in the system—this pressure, if necessary, can be increased and therefore a greater volume of gas transported. Of course, the use of middle pressure requires reducing installations, but these cost much less than the cost of pipe. Moreover, such reducing installations will be needed for only ten years. This question remains undecided, but seems to be easily solved.

The third problem is the storage of reserves of natural gas. It is well known that daily variations in the gas consumption do not require stabilizing gasholders for the long lines, because the large storage capacity of the lines themselves easily solves this problem. On the other hand, the chance of breaks in lines, which necessitates repairs, creates interruptions in the delivery and requires definite gas reserves. In solving this problem, the position of a city in relation to the gas plant must be considered.

There are three sets of conditions worthy of consideration:

1. A town (Krakow) may lie in between two gas producing fields.

2. A town (Ostrowiec) lies close to the center of a main pipe line.

3. A town (Skarzysko) lies at the end of a feeding line.

There is no need to build up a reserve of gas for the first case; for the second, the creation of a reserve depends on the relationship between the volume of gas consumed and the volume of the main line. For the third case, reserves of gas are absolutely necessary.

In building up reserves gasholders with water sealing, or spherical gasholders, must be considered. If the geological conditions permit, then the gas reserves can be stored in the wells. Ultimately, the reserves can be built up on stores of liquid gas. This problem should be given further study as a means of providing the best means for storing reserves for cities. Another problem arises when, taking into account the possibility of a complete exhaustion of gas supplies: Whether we should build local systems for natural gas or for purified coke-gas. It seems that the best solution would be the elimination of the local gas supplies and the use of coke gas delivered from central pipe lines. Natural gas is practically odorless and by using it in gasification of cities it must be odorized, but that is a minor problem. The Oil Institute is interested in all these problems but gas technicians must independently be fully acquainted with these problems and cooperate for their solution. Such problems must be solved before the building of the city gas systems begin, and, as construction is planned for 1951, the search for solution of these problems must begin right now.

REFINING

Eng. St. Niemantowski

THE technical 6-year plan presented by Dr. St. Suknarowski, director of the Trust's refineries, embraces in general, the following problems:

1. Reconstruction and development of producing installations.
2. The development of accessory installations.
3. Execution of scientific-experimental works.
4. Question of supplies.
5. Question of safety and hygiene for workers; the fire danger.
6. Problems of general organization and the technical-economical indicators (coefficients).

Only the problems of points "1" and "5" will be considered. Dr. Suknarowski lays great stress on modernization of refineries working on local supplies and on future construction of refineries — working on foreign oil. The supplies of our own oil are secure and must be handled properly.

An outline of modernization suggests the building of plants for "conservative" treatment of oil with the stress on construction of installations for producing lubricants.

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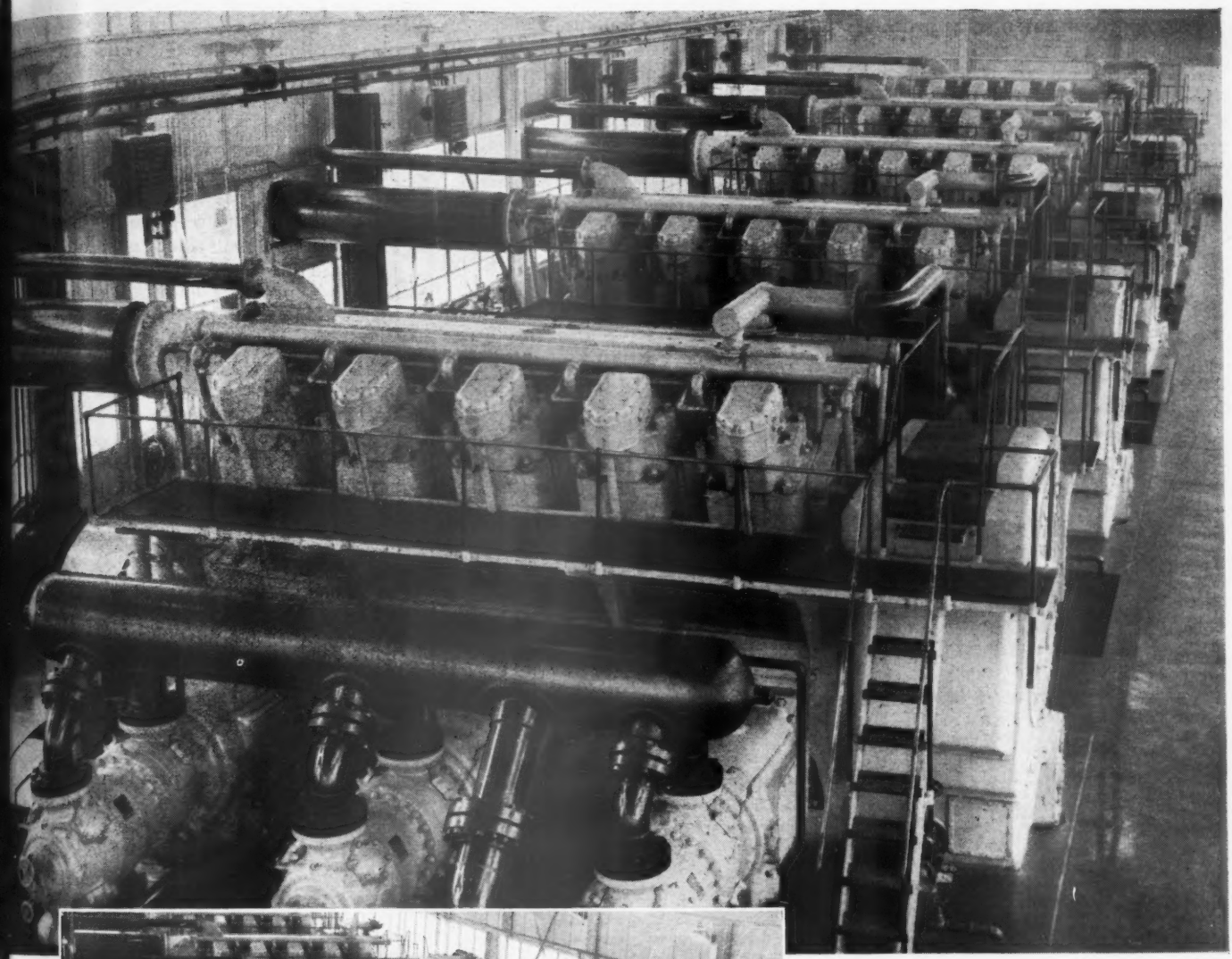

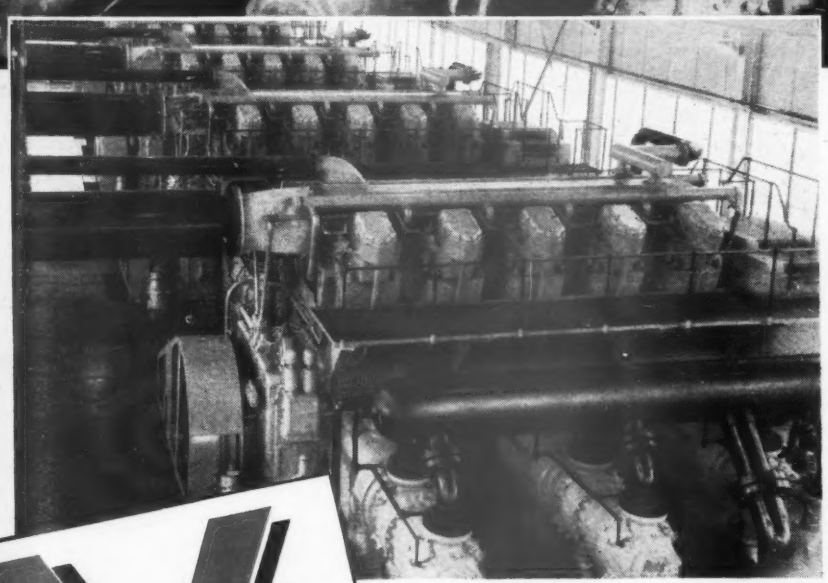

Above: Five of the Cooper-Bessemer GMW engine-driven compressors in Michigan-Wisconsin Pipe Line Company's Guymon-Hugoton Station, showing units from scavenging, blower end. Each has 10 V-type power cylinders, is rated 2500 hp, and drives 3 compressor cylinders.

Shown here from the opposite end, these GMW's, like all Cooper-Bessemer V-angles, feature rigid, one-piece base construction, articulated connecting rods, precision-type, extra-area bearings, and many other important advancements that add up to reliable, low-cost performance.

ANGLE V

Compressors

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This approach is entirely justified for the following reasons:

1. Oil products are in deficit and will be so even after the 6-year plan is completed. Therefore there is no great advantage in building refineries for increased gasoline production as against for production of lubricants.

2. From all oil products — lubricants and, in particular, lubricants for motors are the costliest and most difficult to produce.

3. It is easy to find replacements for gasoline, the main product in cracking, like benzol, industrial alcohol, and other alcohols, synthetic fuels, liquid gas, compressed gases, etc.

4. The building of cracking installations is more difficult than the construction of "conservative" refineries. We are short of specialists and oil-technologists for this purpose. Whereas, in the building of modern "conservative" installations for distillates and solvents we have certain traditions and experience from pre- and post-war periods.

The suggestions for modernization and development of refining are in accord with the directives of the Refining Commission, which was created at the end of 1947 on order of the direction of the "Central Trust for the Petroleum Industry." The direction wanted to know the present position of refining and the possibilities and the trends for its development.

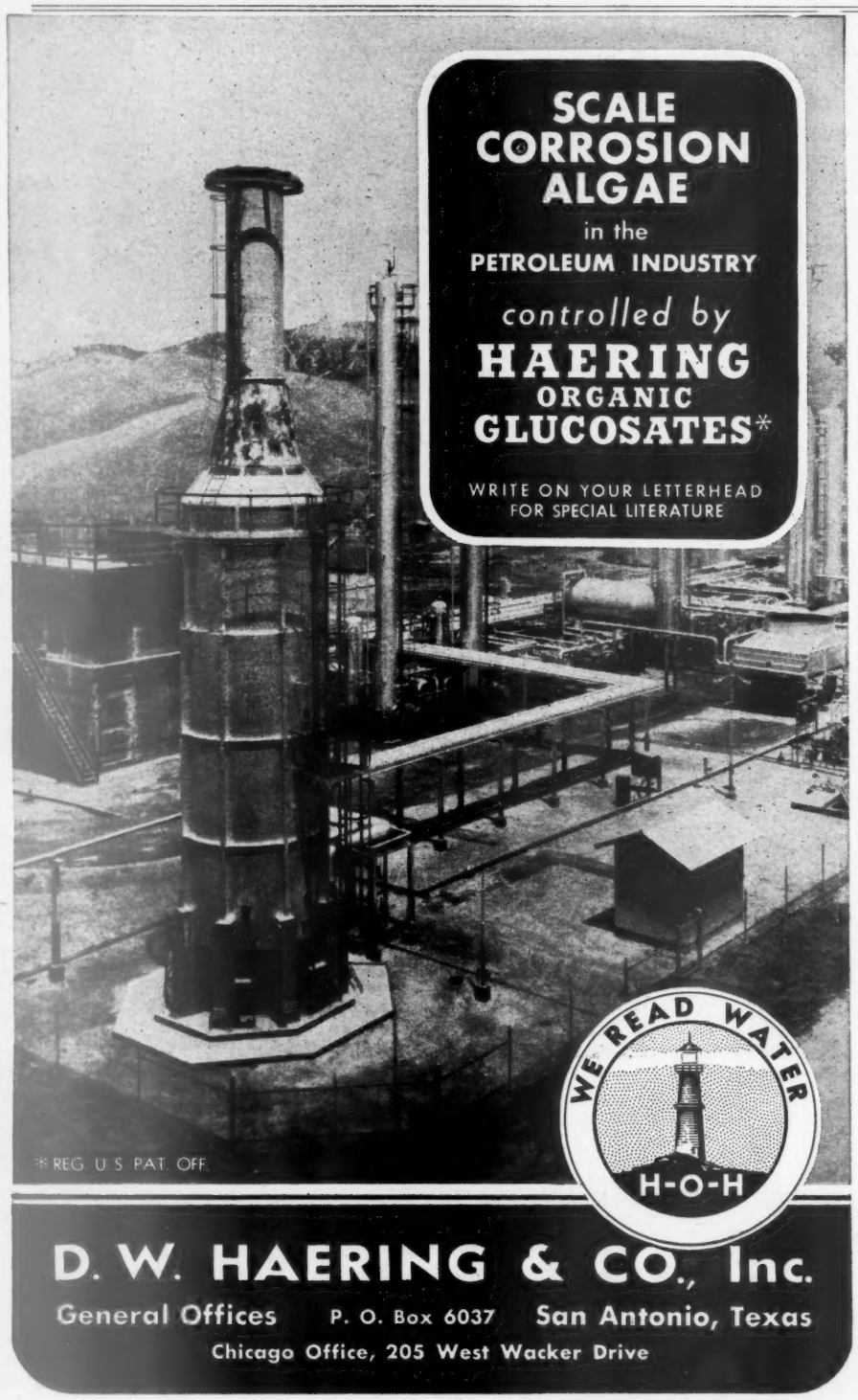
Being in accord with this technical plan, as far as the problem of modernization and development of refineries goes—I venture to indicate the few omitted details that must be included in the 6-year plan, in view of the wage problem and the schemes for new installations. The first problem is the building of a pilot plant for new technological processes. The projecting office of the Oil Trust will start in 1950 the study of solving many technological problems such as the segregation of paraffin in aceto-benzol-mediu, separation of paraffin by propane, by the use of rotary filters, etc. As we lack any experience in this line of refining, a way must be worked out and technical installations must be projected from the data and experience gained on the pilot-plant construction. This will be soon created by the cooperative efforts of the direction of the Refining Trust together with the Oil Institute and the projecting office of the Trust.

Another important problem is the question of producing "agents," which will increase the viscosity index, decrease the temperature of consolidation of lubricants, and other similar problems.

Those problems fall into the realm of chemical synthesis and must be solved by a cooperative effort of the Oil Institute and the Chair of Oil Technology. These above mentioned "agents" for the lubricants and for selective refining will solve numerous problems for power-machinery lubricants.

The third problem is the production of high octane fuel. Notwithstanding the proper attitude that in our situation we should concentrate on the "conservative" refining of oil, we cannot eliminate from our problem the question of production of high octane fuels and related "cracking" products. This problem if not realized in the 6-years plan, must be at least studied and worked out.

In the end, the fourth problem of which I like to take notice, will be the increase in the production of lubricants. Notwithstanding the increase in oil refining and the "conservative" technique we will be short of lubricants. The question of how to solve this problem should be discussed, studied, and fully worked out. In this connection, it is worth mentioning that we could use the old German method, used during the last war, i.e. the "*voltolization*." * * *



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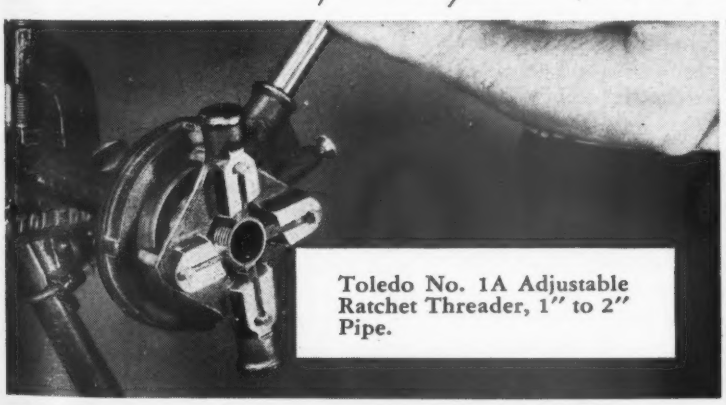

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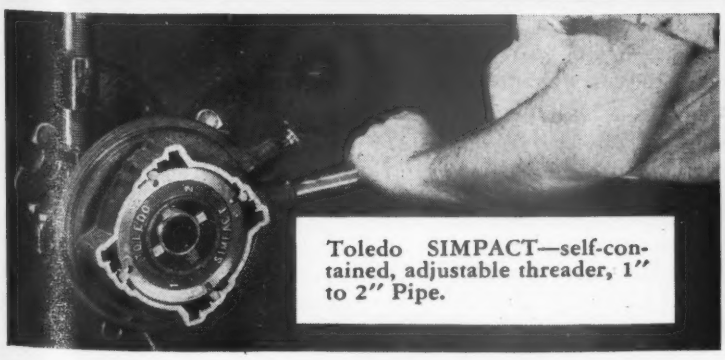

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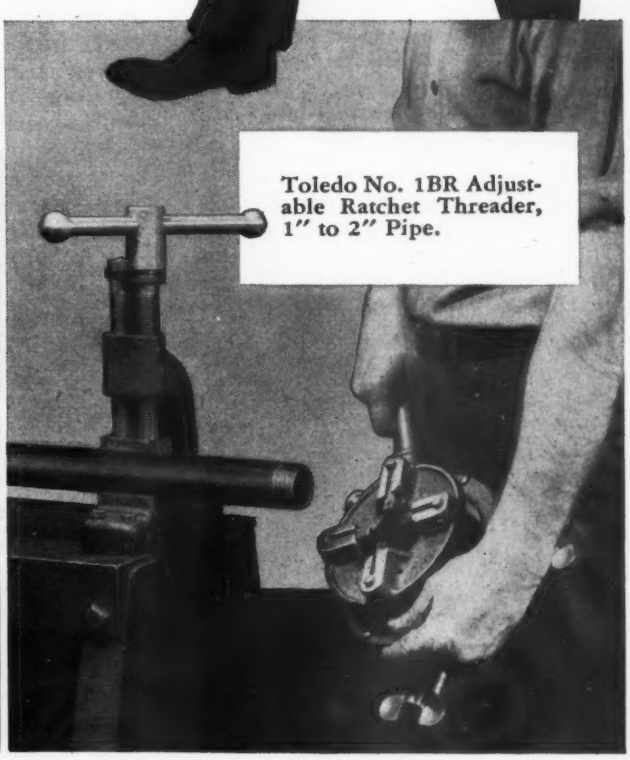

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Part 2

Significant Research in Petroleum Recovery

HARRY H. POWER*

6. Production Practice.

The problems incident to deep-well pumping with rod operated pumps involve research not only in strength of materials, fatigue resisting steels, and factors involved in the resistance of moving parts to abrasion, but also to research in dynamics such as the electric analogue for the study of sucker rod operating characteristics, with the dual objectives of increased lift efficiencies and reduced costs of operation. Continued research in crank shaft dynamometers as well as the conventional polished-rod types should be helpful in effecting a better understanding of torque requirements for pumping units. The application of the strain gauge in the design of pumping equipment should provide fruitful mechanical research under actual field operating conditions.

New long-stroke pumps, hydraulically operated, have been developed to operate successfully at depths below 11,000 ft. New types of hydraulically operated pumping jacks are competing with conventional-type units to effect possible savings in power consumption and upkeep, and provide a pumping motion aimed at reduced failure of sucker rods and other subsurface equipment.

The gas-lift still offers opportunities for improvement through engineering investigations and research. Of particular interest currently is the development of methods for producing small capacity wells in competition with sucker-rod pumping.[23]

Problems involving the handling of crude oil such as paraffin,[18] evaporation,[24] and separation,[10] always have and always will afford opportunity for research. This is also true for salt-water disposal and injection through disposal wells.

A meter recently developed records continuously the ratio of water to oil in the flowing stream, thus facilitating surface gauging of fluid production. Continuous bottom-hole pressure measurements are now read from electrical recording devices at the surface, which promise to be especially useful in determining immediately the effect of such completion and reconditioning practices as perforating the casing into productive strata, observing the effect of water shut-offs, and many other testing and remedial measures.

A new packer has been developed recently which can be set hydraulically without the aid of slips.[18] On one well the packer was set eleven different times without requiring removal. Practical investigation and research on packers of this type has been of portentious aid in the fracture of formations by hydraulic means, in the isolation of gas in high gas-oil ratio wells, in the preparation of fluid input wells, and in many other possible applications.

A bottom-hole flow meter developed for studying well performance has proved to be particularly useful in determining gas flow where the gas comes from more than one zone.

The reliability of potential testing of gas wells by back-pressure methods needs further confirmation by improved methods. The application of thermodynamics to the flow of natural gas wells may result in a better understanding of frictional and other losses and an opportunity to predict temperature as well as pressure drops in the flow strings.

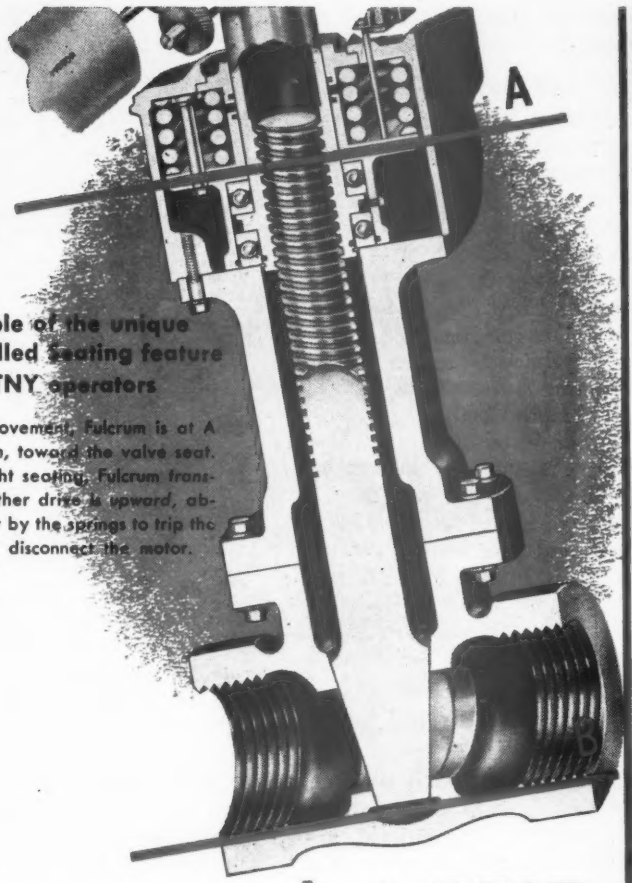
As mentioned previously, corrosion, one of the industry's greatest problems in dollars and cents, comes to the forefront in the research program involving high-pressure gas-condensate wells. This program, instigated by the Natural Gasoline Association of America, is rather formidable from the standpoints of the many angles of attack and the practical solutions that have been offered as a result of research, particularly on the part of the metallurgist and physical chemist. Studies of new types of down-the-hole inhibitors[25] and new corrosion resisting alloys are under way currently. Surface coatings, including plastics and molecular films receive their share of attention. It has been found in some condensate fields that the selection of flow strings of a cross-section that will permit production of the desired amount of gas but at a limiting lineal velocity may insure that the natural protective films on the pipe walls are preserved with consequent reduction of corrosion.[26] This problem should be investigated more thoroughly in laboratory and field.

Practically, for gas drive fields, the recovery has been found to be inversely proportional to the cumulative gas-oil ratio.[27] The growth of gas caps can be followed by observing the gas-oil ratio trends of various portions of the field. Fundamental investigations in reservoir engineering give the answers to many other practical questions in oil production. They show why some oil bearing formations produce clean oil although they contain large amounts of interstitial water. On the other hand, they explain why sands having shows of oil up to 20 per cent may on testing prove to be wet. A mechanism is offered for the increase of gas-oil ratios in gas drive fields following the flush production period, and subsequent decline in the later stages of production.

Muskat has developed a differential method for predicting the behavior of solution gas-drive reservoirs on the basis of previously established empirical laws concerning the flow of heterogeneous fluids through porous media.[28] For the first case of gas injection the gas cap overlying the oil-zone, if present originally, is assumed to maintain a constant volume. In the process of production the injected gas plus the gas in the gas cap initially is supposed to diffuse through and be produced with the oil zone. Additional amounts of gas are required to maintain pressure equilibrium throughout the system. For the second case it is assumed that gas injection occurs with complete gravity segregation, or drainage. The injected gas serves to maintain reservoir pressure only and the operation represents more ideally the popular conception of "pressure maintenance." The ultimate oil recovery, independent for the most part of the fractional return of gas is determined by the value of the residual oil left by gravity drainage, it being assumed that the production rate is restricted sufficiently to permit segregation between oil and gas to keep pace with oil withdrawal continuously. As the gas-oil interface is lowered the producing interval in the well bore is reduced to lie below the contact and the injected gas remains trapped in the gas cap.

In West Edmond a special core ex-

*Professor of Petroleum Engineering, University of Texas.



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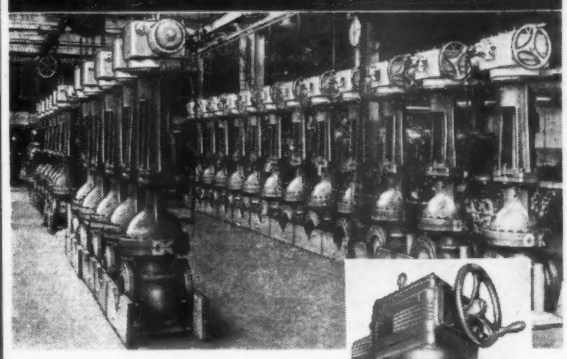
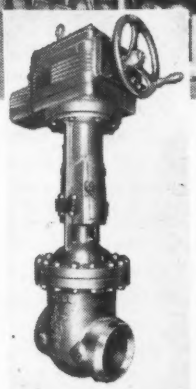
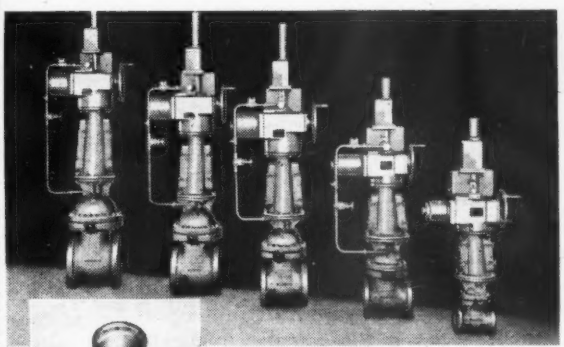
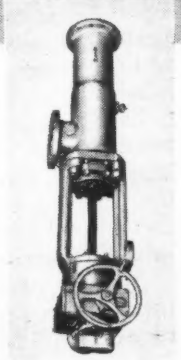


C-H Valve Operators installed on Crane Co. high pressure valves for a processing unit.



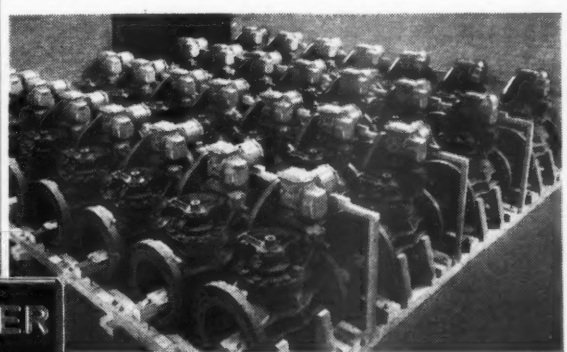
Powell 300 lb. gate valve equipped with C-H operator.





Walworth Valves of varying sizes equipped with C-H operators.

C-H Valve Operator as applied to a Yarnall-Waring Seatless Valve.



C-H operators on Nordstrom plug valves for pipeline service.

amination was made in an effort to ascertain the type and degree of porosity in the Hunton dolomite in accordance with litholigic types.[29] It was found that porosity is of the two general classifications described by Bulnes and Fitting, that is, intergranular and intermediate or fracture porosity. Void space for the fracture system was estimated to be on the order of ten per cent of the total, with the remainder or ninety per cent of the oil in the intergranular or tight porosity. The fracture system was characterized by high permeabilities and the intergranular system by low permeabilities. Hence, the West Edmond reservoir appears to be a complex interrelated system of reservoirs, the fracture system having extremely good communication and the intergranular or remaining portion having no intercommunication. The obvious difficulties with respect to pressure maintenance are worthy subjects for research. It is also apparent that the prediction of performance histories by rigorous calculation is met by such complexities as to become virtually impossible.

In many limestone reservoirs, porosity varies from super-capillary types at the uppermost section of the producing zone to values so small in underlying sections that the problem of elimination of material portions of the latter in the estimation of reserves has assumed research proportions deserving first attention. What is the mechanism of production for this type of pool without unitization or unit operation? What is the essential mechanism under unitization? In the first instance should gas be returned through input wells communicating with the gas cap, or through wells penetrating the less porous portions of the limestone?

Studies of the physical and chemical relationships of fluids and rock surfaces from both the static and dynamic viewpoints, and practical investigation in the field should contribute to a solution of these problems.

Up to this time work on the flow of fluid mixtures in porous media have failed to account for the influence of gravity drainage rates on motion of the fluids. An excellent start has been made in outlining the mathematical problem involved in describing gravity drainage quantitatively under simplified but outstanding problems in multiphase flow and warrants a conspicuous position in production research programs of the future.

Work now under way on A. P. I. Project 47, "Mechanism of the Displacement of Oil from Porous Materials," represents a small beginning to the overall goal of determining the fundamental mechanisms governing the movement of oil through, and its displacement from porous rocks.[5]

7. Pipe Line Flow Research.

In the field of transportation, the pipe-line transmission of natural gas at high pressures is a project which is complementary to the problem of thorough and economical removal of the liquefying fractions.

Two-phase two-complement flow research in pipes[31] has shown the presence of four flow mechanisms which have been correlated by a proper parameter assuming that each phase flows separately. Prediction of pressure drop and of the fraction of pipe filled by liquid or gas has been made. Research for the future will include criteria for the transition between these mechanisms and the acquisition of data to establish definitely the validity of the correlations. The application of this research to petroleum production and reservoir problems becomes a most interesting speculation.

8. Application of Thermodynamics.

Sage and Lacy have suggested the application of thermodynamic data to production practice.[32] Specific suggestions include: Calculation of energy dissipated as friction and efficiency of energy utilization in the reservoir and during vertical flow; prediction of throttling upon the condition of the materials flowing; calculations of additional energy needed, in the form of heat or work upon the materials. Such information can well supplement our present known methods in reservoir engineering practice for the estimation of reserves, and the flow of fluids in the reservoir and onward through flow strings and pipe lines. Research in these fields should be richly rewarded.

The more immediate aspects of research on the phase relationships of hydrocarbons probably include studies with particular reference to the heavy ends of complex mixtures, prediction of critical pressures and temperatures of such mixtures, retrograde vaporization and condensation in condensate reservoirs,[33] and the correlation of critical temperatures and pressures with pseudo-critical and other easily computed properties of the paraffin hydrocarbons.[34] The possibilities of research in this field have long been demonstrated and appear to be so varied and great as to warrant a prominent place in all production research programs, both industrial and academic.

9. Secondary Recovery.

As van Wingen and Johnston[35] have shown, a great many problems in the theoretical aspects of secondary recovery operations remain unsolved. Unfavorable conditions of the past include: Experimental work performed with high permeability recompacted loose sands in lieu of tight consolidate sands; failure to simulate the interstitial water by means of a second immiscible liquid phase; failure to eliminate end effect and leakage of fluids along the boundaries of sand samples; failure of the experimental liquids to exhibit the same characteristics such as viscosity, interfacial tensions, and polar bodies adsorbable on the sand; failure to restrict flow rates and pressure gradients to those actually encountered in the reservoir; and failure to establish economic limits as determined by experimental gas-oil ratios or water-oil ratios in keeping with actual operations.

Hence, better core sampling methods are recommended to give a more valid measure of residual fluid contents.[35] Cores should be taken entirely free from contamination to meet this requirement. The recovery percentage, closely allied with the problem of relatively permeability and interfacial tension, is the most important factor to be estimated prior to the inception of secondary recovery operations and demands additional consideration. Further study should be made of relative permeability for low permeability sands over wide ranges of ratios of oil, water, and gas. Additional work should be done on the optimum rate of fluid displacement with provision made for interstitial water. The effect of delayed drilling and intermittent injection is a problem requiring continued future attention on both analytical and actual field experimental bases.

In addition to the possible projects mentioned, Torrey[36] suggests: The interpretation of electrical logs of partially depleted and low-pressure reservoirs; the prediction of proper injection pressures; the use of explosives in secondary recovery well completion; the prediction of the most effective well spacings and patterns; the prediction of whether water flooding or gas drive will be the most effective secondary method for a given reservoir; and the recovery of oil left by present secondary recovery operations.

Research projects in secondary recovery reported by the U. S. Bureau of Mines[13] include: Use of high-frequency sound waves of great intensity as a possible means for stimulating recovery from oil sands; circulation of hot oil continuously over low gravity oil sand faces for removal of plugging materials; selective plugging of depleted sand sections to minimize channeling of injected fluids; characteris-

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tics of injection wells, including injectivity indices and measurement of conductivity profiles; influence on oil recovery of injection rates and pressures; and methods for maintaining injection rates.

Other suggestions for future investigation and research in secondary recovery include:[37] Plugging methods for bottom-hole water; comparison of rotary and cable-tool cores; limiting water contents of sands for successful floods; optimum injection rates at the beginning of a flood; advantages of salt water as a flooding medium; comparison between rates of detonation, penetrating power, and resulting rock permeabilities in connection with shaped charges;[38] intermittent flowing of producing wells; the formation of emulsions in air-drive operations; the corrosion problem in air-drive operations; the relative effectiveness of air and other substitutes for natural gas in gas-drive operations;[39] the relative effectiveness of recycled air-gas mixtures; the effect of wetting agents and detergents in water flooding; and the extraction of surface-active constituents from crude oils.[13]

10. Electric-Model Studies.

The accuracy with which electric-model studies can predict cycling patterns in a condensate reservoir depends upon the accuracy of knowledge concerning the configuration of the reservoir, its pay thickness, porosity, interstitial water, permeability, and fluid content of its component parts.[40] The value of the prediction also depends upon the known accuracy of production from and injection into any section of the reservoir. In model studies, uniform permeability is assumed everywhere, although the actual reservoir represented may have permeability differences which vary appreciably. The most optimistic picture of gas cycling is therefore determined by model studies. As for the future, it is possible that varying permeability data, if known, may be applied to model studies and the actual cycling program simulated with an increase in accuracy of engineering predictions.

11. General Aspects of Future Production Research.

With more specific general reference to the future of production research, Muskat[41] starts with the almost universal assumption of initial thermodynamic equilibrium within oil producing reservoirs. Studies of chemical and physical reaction rates suggest that reservoir fluid properties must have reached complete thermodynamic equilibrium throughout geologic time. Yet variations of 20 deg API gravity have been observed over several hundred feet of elevation in continuous hydrocarbon reservoirs. Static thermodynamic equilibrium cannot be assumed for such systems. Persistence of chemical transformation processes at rates exceeding those of diffusion, and the role of surface area and geologic periods of exposure as related to possible catalytic reactivity bear investigation as possible causes of net composition changes. How are the reports of gas undersaturation along the flanks of structures initially containing free gas caps to be reconciled with equilibrium concepts? What will be the effect of these phenomena on reservoir performance?

Are capillary pressure phenomena observed under static conditions applicable quantitatively to the dynamic processes incident to oil production? Are the dynamical interactions of gases and liquids at normal temperatures and pressures applicable to reservoirs where the surface tensions may be only a small fraction of those at surface conditions? Does a given difference in wettability between the oil and water phases apply to the whole grain structure and also to the intergranular fines of a reservoir rock? Studies should be made of the microscopic dynamics of the displacement of oil by water. The problems of rate

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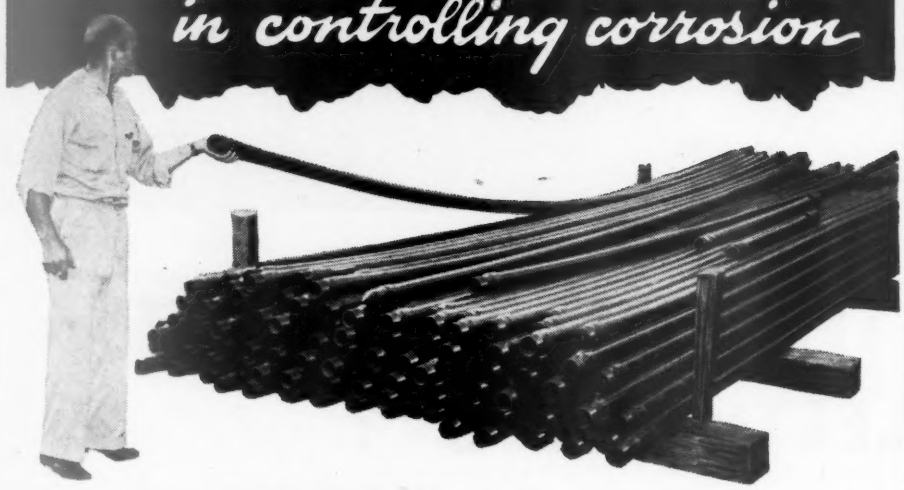

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sensitivity and simultaneous flow of oil and water in individual pores behind an advancing front could then be approached with more assurance.

12. Synthetic Fuels.

So far in this paper only occasional reference has been made to the synthetic fuel industry of the future. Perhaps this type of research should be discussed elsewhere than on a petroleum recovery program. However, if we are to face the future frankly we should not miss the whole picture unfolding before us with a clarity that is unmistakable.

It seems self-evident that we must supplement our petroleum production with other sources, not tomorrow but within a moderate space of years. Synthetic costs will undoubtedly come down and petroleum products may increase. Many states, including Texas, have oil shale, lignite, and coal reserves which should be included in the production research programs of the future.

13. Internal Combustion Engines.

The possible fuel economies of future internal combustion engines deserves passing comment.[42] Engine efficiency is increased, obviously, by the improvement of the cycle on which it operates, and that is accomplished by raising the compression (and expansion) ratio. The increased octane value for fuel is required only if the compression ratio is increased in a single stage as in our present engines with no changes made otherwise. The need for higher octane gasoline can be avoided by employing dual fuels, now under consideration for full-scale commercial trial. Another path which has been suggested is to extend the turbo-supercharger idea, with proper stage compression and aftercooler between supercharger and engine. In addition to the economies mentioned, it is obvious that the reduction of weight per horsepower should effect a corresponding increase in our future oil and gas reserves. As Pigott says: "There are more miles per gallon in lugging 2500 lb of deadweight around than 3000."

14. Economics.

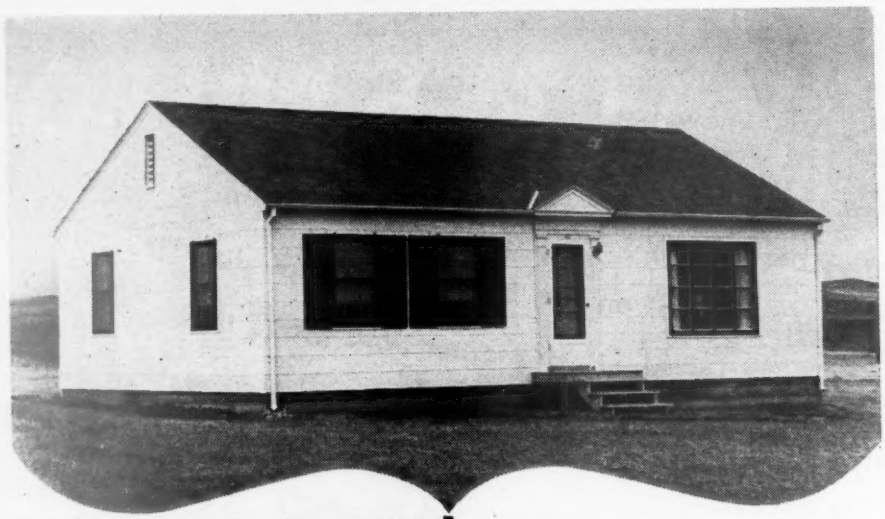
Since we are looking at research problems broadly, problems in economics should not be overlooked.

Of first importance is research in our over-all petroleum economy—imports, exports, supply, demand, and capital formation within the industry. Then, with respect to the more localized problems the questions "will a project pay?"; "why do it at all?" and "why do it now?" are involved in economic selection.[43] The choice may lie between two or more projects or merely between a given project and no enterprise at all. With respect to the payout we are interested primarily in whether the enterprise will pay in the *long run*. Hence, such an investigation demands a thorough analysis of investment, operating costs, fixed charges, depreciation, and maintenance costs.

An academic research problem in the border-zone between engineering and accounting involved a study of depreciation with a view to continuous and critical analysis of the surplus account of a large oil company. Another investigation lead to a business-wise treatment of depreciation and maintenance costs for a drilling contractor who thereby was able to establish what portions of his contract price per foot represented depreciation, maintenance, operating expense and profit respectively.

Indeed, if relief from taxes through proper deductions during years of low prices is the difference between survival and defeat, then practical research in such items as depletion, invested capital, and the capitalization or non-capitalization of development costs assume proportions that cannot be ignored.

Let us keep our feet on the ground in research and not slight economics!



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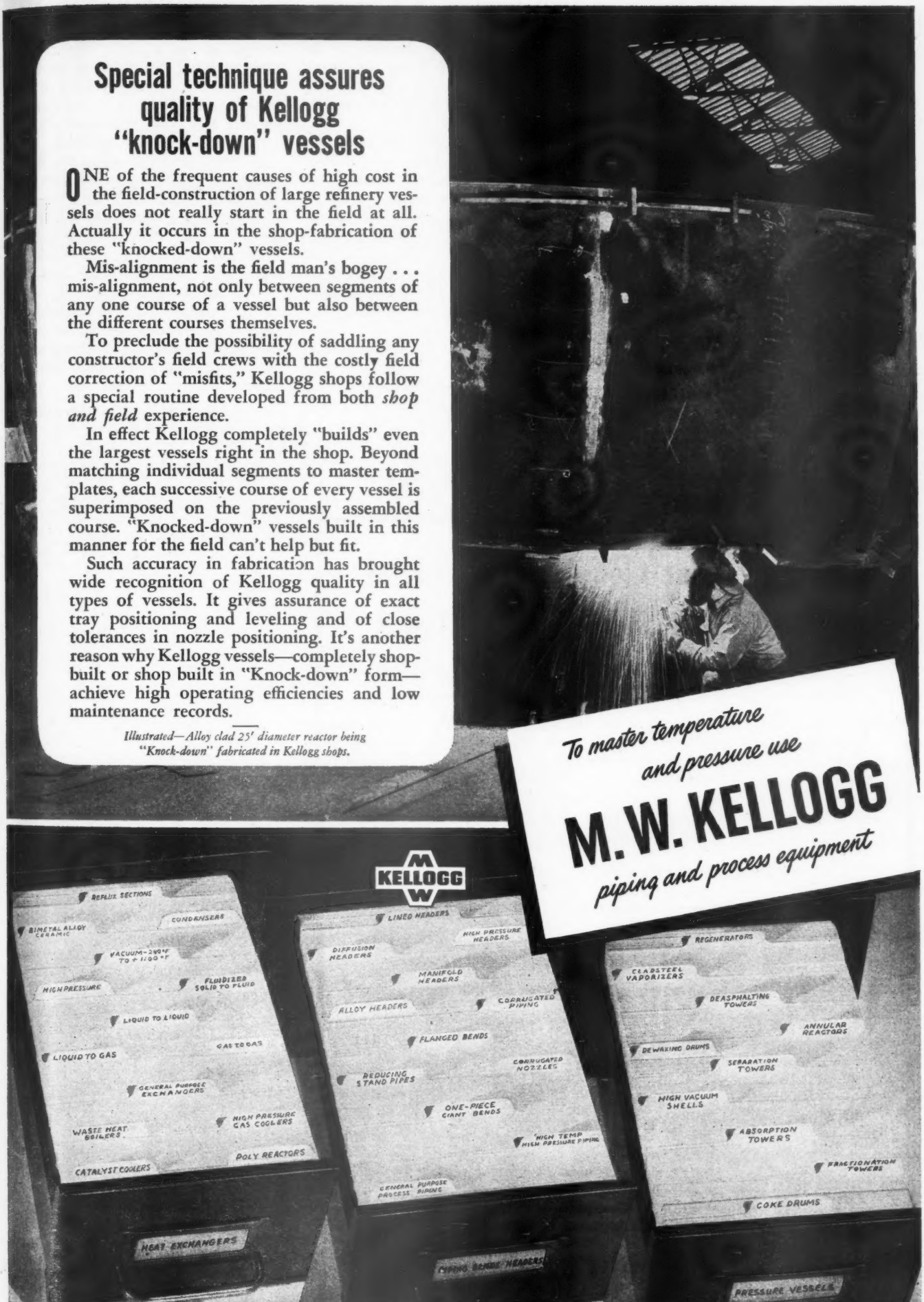

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Conclusions

The concepts and projects mentioned have been touched upon lightly it must be confessed. And yet it has taken long, undoubtedly too long a time to present a list, that, after all is just one person's viewpoint of what is important. Undoubtedly your individual list of favorite topics for research would be as time consuming, if not more so. But, herein lies encouragement—that production research offers endless avenues for search into matters of truth. There is room for all! Duplication of effort is unnecessary. Individual contributions may not be spectacular and often may prove to be monotonous. But the sum total of all efforts may be likened to the mighty river fed from un-named streams—it assumes a major importance and purpose in the progress of the industry that it serves.

Kettering has helped me bring this paper to a more fitting conclusion. "Research" he advises, "is a high-hat word that scares a lot of people. It needn't. It is rather simple. Essentially it is nothing but a state of mind, a friendly, welcoming attitude toward change. Going out to look for a change instead of waiting for it to come. Research, for practical men is an effort to do things better and not be caught asleep at the switch. The research state of mind can apply to anything: Personal affairs or any kind of business, big or little. It is the problem solving mind as contrasted with the let-well-enough-alone mind. It is the composer mind instead of the fiddler mind. It is the tomorrow instead of the yesterday mind."

If it takes imagination to get what we are going after, then we are all researchers. The sixth verse of the 11th chapter of Genesis may become a fulfillment sooner than we expect:

"And the Lord said Behold, the people is one, and they have all one language . . . and now nothing will be restrained from them which they have imagined to do."

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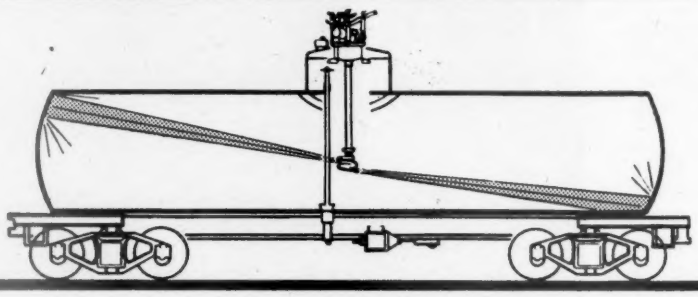

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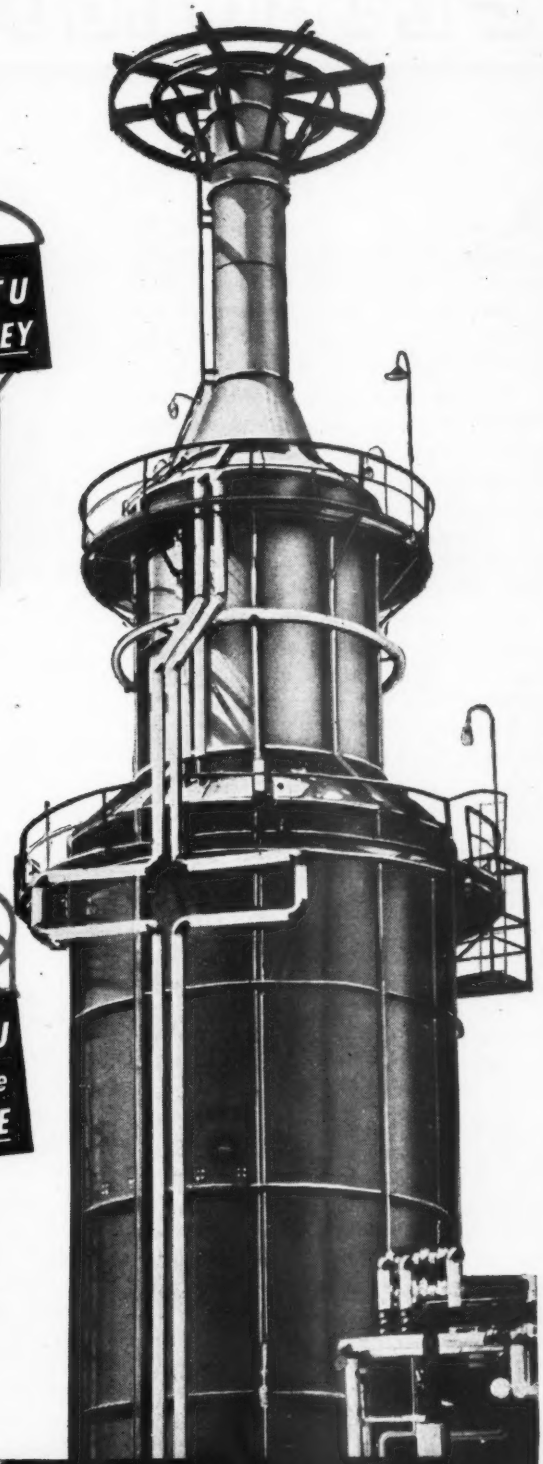

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PETROLEUM PROFILE

A PROMINENT new member of the rapidly growing oil fraternity in Edmonton, Alberta, Canada, is Loren F. Kahle, recently elected executive vice president of Interprovincial Pipe Line Company, Limited, of Canada.

Now on a special 18-month leave of absence from his position as president of Interstate Oil Pipe Line Company, Kahle has been placed in charge of the construction and the development of operating plans for Interprovincial's proposed 1150-mile pipe line from Edmonton to the Great Lakes.

Acceptance of the special Canadian assignment, was for Kahle a return to his place of birth, for he was born in Toronto of American parents.

In 1910, his family moved from Toronto to Oklahoma City, Oklahoma, where Kahle graduated from high school in 1920.

Receiving his B.S. degree in mechanical engineering from Iowa State College, Ames, Iowa, in 1924, Kahle was employed by the Standard Oil Company of New Jersey (now Esso Standard Oil Company) as a laborer in the Bayway refinery utility gang. He has continued to serve with various affiliates of Standard Oil Company (New Jersey) since that date.

At Bayway, Kahle worked up to the position of fireman on crude stills before transferring to the general engineering department. Then, in January, 1925, he was made a traveling inspector of high pressure fractionating equipment. This position entailed trips to affiliated refineries in Cuba and Mexico, as well as those in the United States.

In June, 1925, he transferred to Cia. de Petroleo Transcontinental S. A. in Tampico, Mexico, and he remained in Mexico until September, 1935. During this 10-year period his experience was in production and pipe line operations, and construction. The operations of the Company extended over all northeastern Mexico from Tampico north to the Rio Grande Valley.

In 1935, Kahle left Mexico to become chief engineer of the Standard Oil Company of Venezuela. In this capacity he had charge of construction of pipe lines, camps, wharves, and roads. In 1941 he was named superintendent of the company's terminal at Caripito.

Loren F. Kahle

During the war Kahle worked with the United States Navy, assisting in the construction of pipe lines across the Isthmus of Panama.

In 1943, he returned to the United States as superintendent of petroleum transportation of The Carter Oil Company, in Tulsa, Oklahoma. When Interstate Oil Pipe Line Company was formed in 1944, Kahle was elected executive vice president of the new company, and in December, 1945, was elected president. As head of Interstate, he was responsible for merging the operations of two pipe line systems, both of which have histories dating back to 1909. These were the pipe line properties of the Standard Oil Company of Louisiana and the Oklahoma Pipe Line Company system, which, during December, 1944, were combined to form a common carrier pipe line affiliate of Standard Oil Company (New Jersey).

Though he will be inactive in the management of Interstate for the duration of his special Canadian assignment, Kahle will retain his present position as president, and will maintain his home in Tulsa.

At home are Mrs. Kahle, the former Miss Helen Herr, whom he married in 1927, and two sons, Robert and Richard. A third son, Loren, Jr., is attending Cornell University.

Since coming to Tulsa, Kahle has been active in Boy Scout work, having served as a member of Troop 20 committee in 1943, and as Tulsa Area Council president in 1948 and through September of 1949. He was appointed a director of the Tulsa Chamber of Commerce in 1947, 1948, and 1949, and during the first two of those years served also as chairman of the Chamber's oil activities department. He is also a member of the central committee for transportation of the American Petroleum Institute.

Kahle's principal hobbies are golf, fishing, and boating. For some time he has maintained a camp on the shores of Grand Lake, near Tulsa, where he has indulged in the latter hobbies on weekends and vacations when the weather permitted. * * *

Operation Problems Simplified

As one travels through the new oil fields of Scurry County or other petroleum producing areas and checks operating problems, one is impressed with the growing importance of the service and supply companies that move in and establish headquarters for helping the operators and drilling contractors from the time a field is discovered until it is abandoned. Service and supply companies have always played an important part in the development and operation of oil and gas fields. Today's development and operating problems are greatly simplified, however, by the increased availability of tools, equipment, and services.

An operator now does not need to buy much, if any, servicing or rig equipment, and he does not need to recruit and house a large number of workers. Likewise, it is more or less unnecessary for either large or small operators in an area to build large warehouses or equipment yards. Few tools and materials need to be warehoused. The reduction that is now possible in capital investment, labor force, and overhead is a direct result of the improvements that have been made over the years by the supply companies and the contractors who place themselves in a position to serve the operators.

The equipment needed for drilling and completing wells is much more portable now than ever before. Roadbuilding equipment, draglines, drilling rigs, well-logging units, casing cementing and perforating equipment, acidizing and swabbing machinery, and many other types of well servicing equipment are now designed for rapid transportation to and from the well sites. Today's operators in most areas may simply notify the service or supply companies of their development plans and contract for the work that needs to be done.

Access roads may be graded and graveled; pits may be dug (and filled after wells are completed); drilling rigs and derricks may be moved on and off well sites without needing much time for rigging up or tearing down; and tank batteries, separators, treaters, and lease buildings may all be installed and completed by contract. An operator today does not have to maintain a large force of supervisors, engineers, and workers to take care of these field development programs. Service and supply companies cooperate closely with the contractors that stand ready to take care of an operator's requirements, and they are as near the wells and the work as the nearest phone or radiotelephone.

K Marshall Fagin

"Whirling on center" is the key to Cementing Success

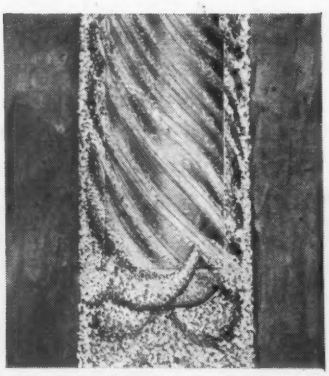
NO OTHER EQUIPMENT—no other method of cementing—provides such assurance of successful "first-time" cementing as the exclusive Baker Principle of "whirling" the cement up and around casing which is effectively centered in the well with Baker Model "G" Casing Centralizers.

Not only can you REMOVE BRIDGES which might stick the casing; not only can you wash the wall of the hole to help REMOVE MUD CAKE and leave the formation prepared for effective bonding with the cement to follow, but the definite *downward*, then *upward* whirling motion of the cement slurry REDUCES THE HAZARD OF CHANNELING TO A MINIMUM, and assures COMPLETE ENCASEMENT OF THE PIPE at the critical shoe joint with a uniform body of cement.

Study the illustrations below for visual proof of what "whirling" means to you.

The downward hydraulicking action of the circulating fluid through the baffled side down-whirler ports, and the nozzle-like bottom passageway, effectively remove bridges and permits safe running of the casing string.

When washing the formation at the cementing point to condition the hole, the "whirling" motion of the fluid helps remove mud cake from side walls. This *downward* whirling is far superior to any *side* jetting action, and does not cause caving or crumbling of soft formations.



The "whirling" motion given to the cement slurry as it is discharged from a Baker Wash-Down Whirler Shoe causes the cement to encase the centered shoe joint with a uniform body of cement, and reduces to a minimum the hazard of channeling.

Fig. 1

FISHING TOOLS AND METHODS

Classification of fishing jobs and examples of technique developed to shorten time needed

PHILIP W. MARTIN*

MAJOR advances in the design and application of fishing tools and equipment, during recent years, have been responsible for shortening the average fishing job. New tools and techniques have reduced fishing job time from two or three months to only a few hours.

In the past, it seemed to most oil men that more time was spent fishing than drilling. One of the most common and time-consuming fishing problems during drilling operations was stuck drill pipe. Although drill pipe still becomes stuck, its occurrence is not as common today as it was in the past. This is due, in part, to the use of special tools[1] in the drilling string. Most of these tools are designed to withstand the extreme pressures and temperatures encountered in deep well drilling operations. In the world's deepest well,[2] which was drilled last year, a double acting rotary jar[3] was used from 13,000 ft to the record depth. It freed the fish after 36 hrs of continuous operation. When examined after being pulled from the well, the jars were found to be still in good condition.

There are three main classifications of fishing jobs:

1. Stuck drill pipe, tubing, liners.
2. Lost items in the bottom of the well, such as: reamers, cores, bits, broken shanks, slips, etc.
3. Salvaging casing in abandoned wells and removal of pipe in producing wells.

Each type of fishing job requires the use of specialized tools and methods to solve the problem.

For example: When drill pipe becomes stuck the first thing the operator wants to know is, just WHERE it is stuck. There is one tool, an electronic device,[4] that can answer that question quickly and accurately, the key tool in many fishing operations.

Today, the effectiveness of this tool is so well known that most operators instruct their drillers to call for it when trouble occurs; realizing that, in a case of this kind, the most important thing is to find the exact point at which the pipe is stuck. If the tool is run immediately, and quick remedial steps are taken, fishing time and cost may be held down.

The electronic device[4] is so sensitive that it may locate the stuck point within inches in a short time. After locating the stuck point, the operator usually has a choice of methods for freeing the pipe. The action of the meter on the electronic device may indicate the type of medium that is holding the pipe. This indication may be of great assistance in determining the selection of fishing methods.

One method of freeing the pipe is to spot oil in the area that is sticking the pipe. In some cases, however, in waiting for the fluid to act, caving occurs, sticking the pipe at some other point.

Another method commonly used, is to run inside cutters into the pipe on macaroni or sucker rods. This method is time consuming, as macaroni or sucker rods are not usually available at the well.

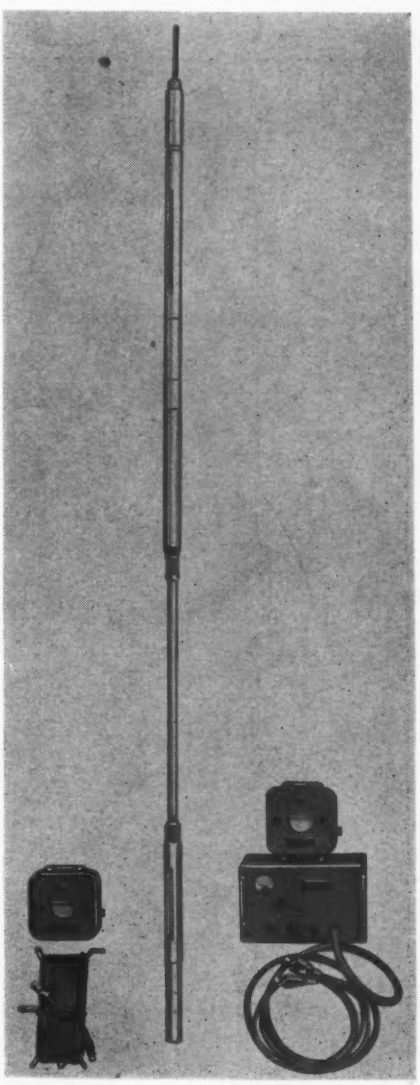
Another method[5] consists of placing a series of explosives.[6] When detonated above the stuck point, after torque has been applied, the jar of the explosion loosens a joint, permitting the free pipe to be unscrewed and recovered immediately.

A "jet" tool[7] has been developed to "back-off" the free pipe. The main difference between the two back-off methods is that the jet tool is positioned positively in a joint whereas the explosive[6] laps the joint. Use of either back-off method eliminates running in and out of the hole with tubing to make a cut mechanically. The saving in time in an 8000-ft well amounts to about 12 hrs.

The combination of the electronic device[4] and either one of the two back-off methods has reduced the number of fishing tools required and has accelerated the recovery of pipe. This combination of tools offers two methods of drill pipe recovery:

1. The first method applies only to the jet tool.[7] The stuck point is located with the electronic device. The pipe is then "normalized" as to weight. The jet tool is then positioned in, or at the top of, the drill collars, and a joint is loosened there. Then, joints a.[illegible] loosened progressively, in stages com-

The electronic device used in many fishing operations, is designed to locate the stuck point in casing, tubing or drill pipe quickly and accurately.



EXCLUSIVE

*Director of Research, Western Division, McCullough Tool Company.

[1]Such as the McCullough Double Acting Rotary Jar.

[2]Superior's Pacific Creek No. 1, Sublette County, Wyoming.

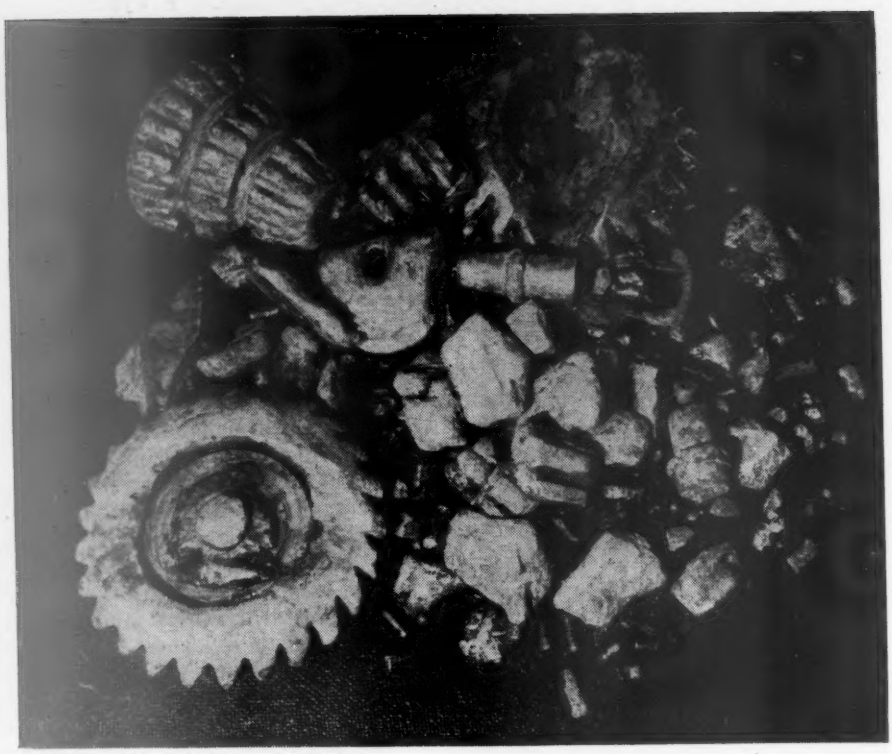
[3]Manufactured by McCullough Tool Company.

[4]The Magna-Tector.

[5]The string shot method designed by Ford Alexander.

[6]Primacords.

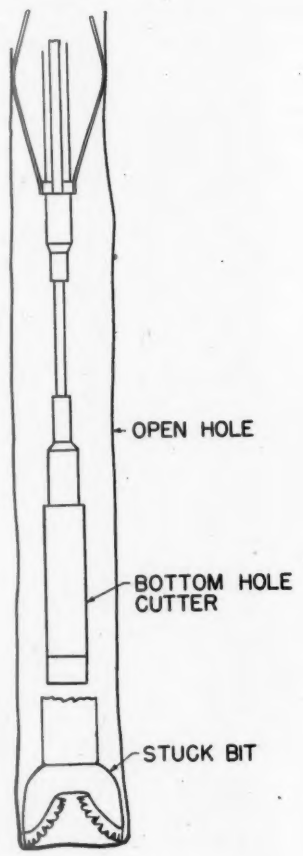
[7]McCullough's jet back-off tool.



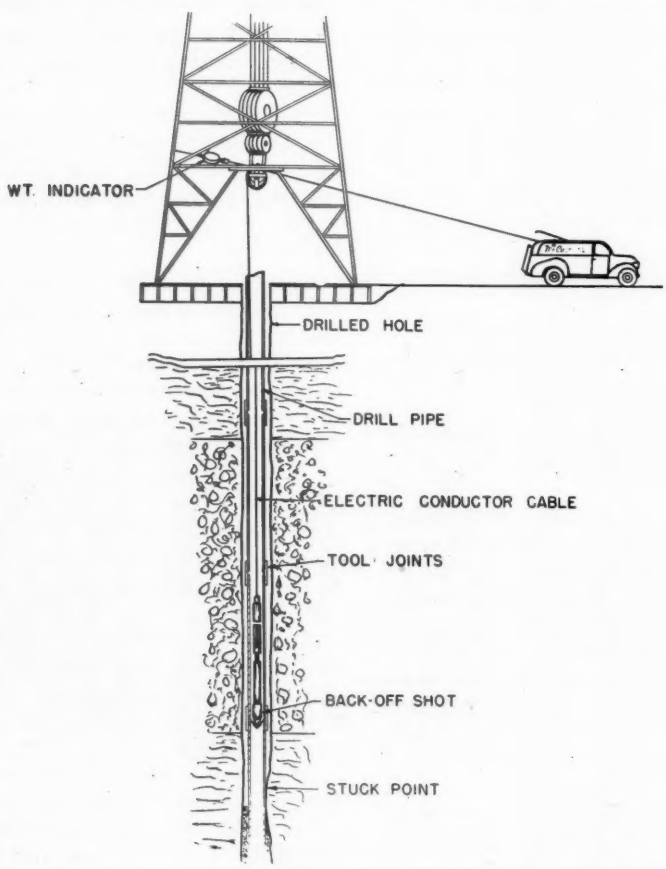
Fragmentized pieces of a stuck bit after being shot by a jet bottomhole cutter and recovered from a well.

parable to the length of wash pipe available. Next, the jet tool is located in the first joint above the freeze point, discharged, and the pipe is backed off. This permits the immediate recovery of all of the free pipe, leaving only the stuck portion of the pipe in the hole. After the free pipe has been removed from the well, wash pipe is run, and the impacted material that is holding the pipe in a stuck condition is washed away from the first section or down to a joint that has been loosened prevously by the jet tool. The drill pipe may then be run back in, and the top of the fish contacted. The washed-over section is then backed-off at the joint that was loosened previously, while the pipe was still stuck. Repetition of these operations should effect recovery of all of the pipe from the well.

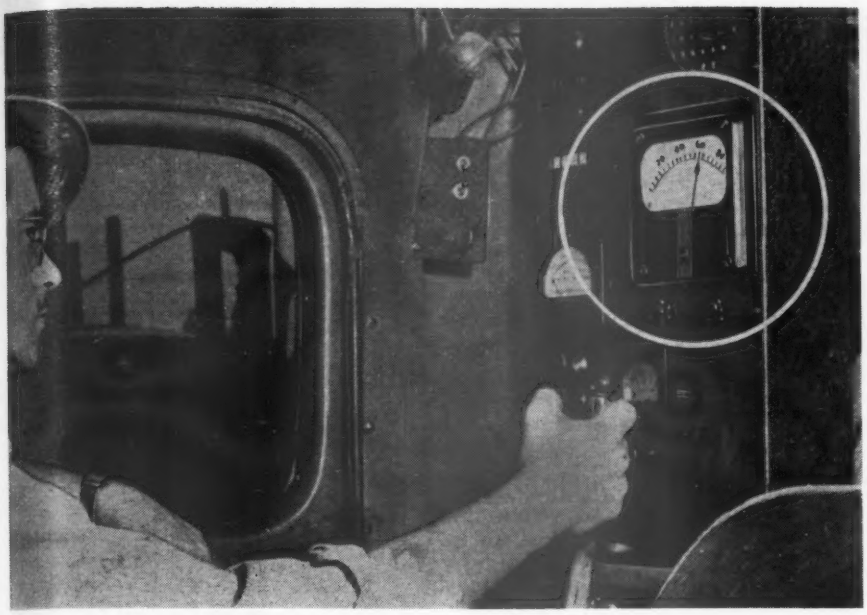
2. The second method applies to both the series of explosives[5] and the jet tool. In the case of the explosives, torque is applied before backing off. with the jet tool, the pipe is normalized as to weight and the shot fired before backing-off. In this method, the first joint above the stuck point is loosened by action of either back-off tool, and



A jet bottomhole cutter is positioned directly above a stuck bit in the bottom of the well.



The jet back-off tool shown in position in a tool joint. When shot it should loosen the joint a few thousandths of an inch, permitting the joint to be unscrewed.



Operator in an electric service truck controls all electric wire line fishing tools by means of various electronic devices.

all free pipe removed. Each section, thereafter, is washed over before using the explosives[3] or jet tool. This procedure is repeated until all the pipe is recovered.

When obstructions in the well make it impossible to run fishing tools inside the pipe, external cutters must be used. Outside cutters often have thick walls, and in many cases clearance between the tool joints and drilled hole is so small that these cutters cannot be used. A slim-hole external cutter,[8] however, is now available. This cutter was used recently in a well in Texas. The drilled hole was 9 in. in diam and the tool joints were 7 in. in diam, leaving a clearance of less than 1 in. A slim-hole cutter with an OD of 8⅝ in. and an ID of 7⅛ in. was used to make the desired cut.

The second type of fishing job is fishing for lost items in the bottom of the well. When other methods fail or when it is realized that the fish is large or bulky, a jet bottomhole cutter may be used. This tool may be positioned directly over and used to destroy or fragmentize such items as: reamers, bits, cones, bit heads, broken shanks, slips, underreamer lugs, diamond core heads, orange - peel - type bull plugs, etc. The fragments may then be recovered so that drilling can continue.

The third type of fishing job is salvaging casing in abandoned wells or removing pipe from producing wells. The method used is similar to the procedure is recovering stuck drill pipe. The only difference is that the pipe is severed by means of another jet tool[8] instead of being backed-off at a joint above the stuck point. The electronic device is used first to locate the stuck point, then, the jet casing cutter is run in on the same wire line to a point above the stuck point. It severs the pipe when fired. When severing an inner string of casing the outer string is not damaged as the jet casing cutter utilizes the principles of focusing detonating gases to a beam. Distance is the only barrier in this type of explosive, and the force is focused to the thickness of the pipe only.

There are two main types of fishing tools:

1. Tools run in on an electric wire line and controlled at the surface by an electric service truck. The electronic device[4] and jet tools come under this classification.

2. Tools run in on tubing or drill pipe and controlled mechanically from the surface. A few tools in this classification are: Internal cutters, external cutters, releasing spears, releasing sockets, bumper subs, safety joints, double acting rotary jars.

Jet and electronic fishing tools have not replaced all mechanical or hydraulic fishing tools. There are certain applications where mechanical tools and only mechanical tools may be used to recover the fish effectively. Well conditions and requirements of the operator are the deciding factors in the selection of any specific tool or method.

Electronics plays an important role in the surface equipment that controls and records the progress of all wire line fishing tools in the well. The service man in an electric service truck has at his command various electronic devices, mechanical aids and sonic devices, so that he not only knows the location of the tools by sight, but by sound and feel also. One of the surface electronics devices is a supersensitive weight indicator. It is attached to the derrick sheave by means of a tie-back chain. It is so sensitive that a weight change is actually recorded simply by touching it, yet it maintains this same sensitivity over its entire range of several thousand pounds.

Another electronic principle is put to use in a sonic device run on the electric wire line, in combination with all wire line fishing tools that re-

Double acting rotary jar used in the drilling string in the world's deepest well.

[8]The jet casing cutter.

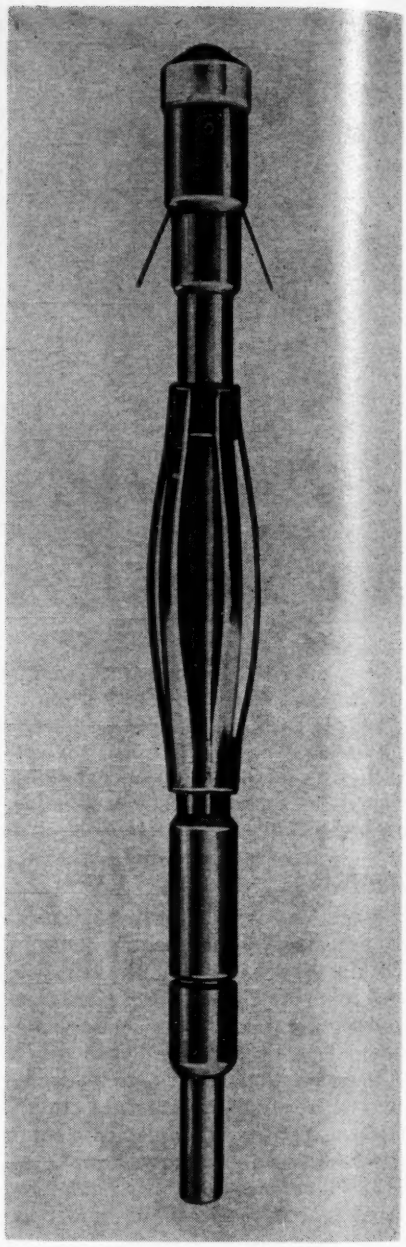
Firing head of a jet back-off tool. Note collar finder fingers that positively position the tool in the box of a tool joint.

quire positive location of all collars and tool joints. As the tool is lowered into the well, the operator hears the sound caused by collar finder fingers as they scrape along inside of the pipe. A distinctive sound is heard, each time these fingers drop into a coupling, collar or tool joint, and by means of an odometer these measurements are recorded. By tallying these measurements with those of the oil operator, a double check is procured. Due to this triple check — sound, sight, feel — wire line fishing tools may be lowered rapidly into the well, saving considerable rig time.

Various combinations of fishing tools are sometimes necessary to complete a specific job. Since no two fishing jobs are exactly alike, fishing tools must be designed and arranged so that they can be used in combination with one another.

For example: At an oil field near Edmonton, Canada, the drill pipe suddenly became stuck. The electronic device was used to ascertain the stuck point. Bullet-type gun perforators[3] were used to put holes in the drill pipe to improve circulation and to increase the velocity of the drilling fluid. The jet tool was used to loosen the first tool joint above the stuck point. Double acting rotary jars were used in jarring the remaining fish, operating continuously for about 36 hr without trouble of any kind. The drill collars were jarred up the hole 20 ft, but became so thoroughly stuck at that point that further jarring would not move them. The jet tool was then run through the jars, backing-off the pipe effectively. Spears[3] and sockets[3] were subsequently used to recover the complete drilling string without cutting or damage of any kind to the pipe or joints.

The oil operator accepts a new tool only after usage has proved its worth. Developing a new tool from an idea to a finished product may take years and the cost is staggering. At present day operating costs, estimated at $900 a day per rig, every hour spent in non-drilling activities is a waste of money. The high cost of research is repaid when a new tool has proved its worth and actually does its specific job faster, better, and or more efficiently than former tools. In the end, it is the oil operator who gains most from these new tools. His overall rig time is materially reduced, he can drill more wells in less time and with the least amount of trouble, and many of his wells are saved that would otherwise be lost. * * *



The jet casing cutter is designed to sever the pipe instantly without damaging an outer string. Note collar finder fingers.

One of the surface electronic devices used with all wire line fishing tools. This electronic weight indicator is so sensitive that changes in weight may be recorded simply by lightly touching it.

Gas-Oil Ratio Repair and Control[1]

T. B. LAMBERT* and R. M. HIPPARD†

THE increasing value of natural gas and the closer attention given by the regulatory bodies of Texas and New Mexico to gas-oil ratio behavior has lately focused special interest on the control and conservation of gas.

The 16 Texas fields analyzed in this paper have a top limiting gas-oil ratio of 2000 cu ft per barrel of oil, with the exception of the North Cowden Field with 3000, the Fuhrman-Mascho Field with 3500, and the Seminole Field with 2500 cu ft per barrel. The top limiting ratio in the Wasson field was reduced from 5000 to 2000 cu ft per barrel of oil in November, 1947. The trend set by the Railroad Commission of Texas in top allowed gas-oil ratios appears to be downward.

The eight fields in New Mexico considered in this report have varying gas-oil ratio limits as follows:

Field	Cubic Feet Per Barrel of Oil
Bowers	2000
Cooper-Jal	No limiting ratio
Drinkard	2000
Eunice and South Eunice	6000
Hobbs	3500
Monument	3000
Paddock	2000

Similar to Texas, the trend of limiting gas-oil ratios, as set by the Conservation Commission of New Mexico, is downward. The newer fields, such as Bowers, Drinkard, and Paddock, have top allowed gas-oil ratios of 2000 cu ft per barrel, or less than the older fields.

In both states, gas limits for individual wells are set and the penalized allowable is that amount of oil that can be produced with the gas assigned each well. For example, in the Wasson Field of Texas, a well with an allowable of 50 bbl per day is allowed to produce 50 times 2000 (top gas-oil ratio limit), or 100,000 cu ft per day. If the gas-oil ratio is determined to be 4000 cu ft per barrel of oil, the well is assigned an allowable of 100,000 divided by 4000, or 25 bbl per day. The same method of penalizing wells with ratios in excess of the legal limit is used in New Mexico, with the exception that the gas limit for any individual well is determined by multiplying the top allowable in the field by the limiting gas-oil ratio.

Gas-oil ratios are normally reported once a year to the regulatory bodies of each state.

The 24 fields covered in this report are in the Permian Basin of West Texas and New Mexico. Essentially all of the work analyzed was performed on wells in limestones and dolomites of Permian Age. Some of the reservoirs have an active water drive with a free gas cap and others are of a closed or depletion type, and usually have an original free gas cap.

This paper was prepared to investigate in as comprehensive a manner as possible the entire question of gas-oil ratio repair and control in West Texas and New Mexico. Gas-oil ratio repair questionnaires were sent to as many operators in West Texas and New Mexico as could be contacted. A sample questionnaire form is shown in Fig. 1. From completed questionnaires, comparative results of as many jobs as possible were examined.

The large amount of data examined gave a very complete cost picture of various types of repair jobs and of relative costs in different fields, as well as outlining some general guides or criteria that may aid in future gas-oil ratio repair work.

FIG. 1

QUESTIONNAIRE FOR REPORTING OF DATA FOR API REPORT ON GAS-OIL RATIO REPAIR AND CONTROL IN WEST TEXAS AND NEW MEXICO

SUMMARY OF CORRECTIVE WORK TO REDUCE GAS-OIL RATIO

FIELD _____ OPERATOR _____ WELL _____

GENERAL DATA

PAY FORMATION _____ TOP OF PAY _____ ELEVATION _____

COMPLETION DATE _____ INITIAL POTENTIAL _____ COMPLETION GOR _____

PERFORATIONS _____ CASING POINT _____ TOTAL DEPTH _____

GAS WORKOVER DATA

PURPOSE OF WORKOVER _____ DATE OF WORKOVER _____

TYPE OF WORKOVER _____

ESTIMATED CUMULATIVE OIL RECOVERY AT DATE OF WORKOVER _____

PRODUCTION DATA BEFORE WORKOVER	PRODUCTION DATA AFTER WORKOVER
OIL GAS RATIO _____	GAS-OIL RATIO _____
DATE OF PRODUCTION _____	DATE OF PRODUCTION _____

RESULTS OF TESTS AFTER WORKOVER

TEST 1	DATE _____	PRODUCTION _____	GOR _____
TEST 2	DATE _____	PRODUCTION _____	GOR _____
TEST 3	DATE _____	PRODUCTION _____	GOR _____

ESTIMATED OVERALL COST OF JOB _____

DESCRIPTION OF WORKOVER _____

INTERPRETATION AND/OR REMARKS _____

Criteria Used In Analyzing Data

From the data given on each questionnaire form having sufficient information, the jobs were classified as: (1) Success, (2) Partial Success, or (3) Failure.

A job was rated a *success* if the gas-oil ratio was reduced below the unpenalized gas-oil ratio of the field for a period of at least 6 to 12 months. The varying period of time depended somewhat on the completeness of the follow-up production and gas-oil ratio date. In 27 jobs that were accomplished recently and on which no follow-up data were available, some were rated successes based on the authors' judgment.

A job was rated a *partial success* if the gas-oil ratio was appreciably reduced, but not below the legal limit of the field, for a period of at least 6 to 12 months. If the ratio was reduced initially to below the legal limit for a period of approximately six months, but gradually rose to the ratio prevailing before the work, the job was likewise rated a *partial success*.

A job was classified as a *failure* if no beneficial results were obtained.

The life or length of time that beneficial results were obtained from a job was considered to be the length of time required for the gas-oil ratio to exceed the top allowed ratio for the particular field. The life was not extended beyond the date of the last information, even though the gas-oil ratio at that time was still below the top allowed limit. The life was determined only for certain jobs rated *successes*.

The gas-oil ratio before a job was that listed by the operator filling out the questionnaire form. The average gas-oil ratio after the work was performed was the average ratio shown by the subsequent tests during the life after the job. The gas-oil ratio before and after workovers was determined only on a selected number of jobs that were rated *successes*.

The data were also divided into 10

[1]Presented at the Spring Meeting of the Southwestern District API Division of Production, Dallas, Texas, March 10, 1950.

*Shell Oil Company, Inc., Odessa, Texas.
†Shell Oil Company, Inc., Hobbs, New Mexico.

Table 1. Analysis of all GOR repair jobs by types of jobs.

FIELD	FORMATION PACKERS	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PER. IN CASING PERFS.	COMBINATION JOBS	MISC. JOBS	TOTAL JOBS ALL TYPES
GOLDSMITH											
Number of Jobs by Type	127	54	12	4	10	18	13		5	1	
Percent of Total Jobs in Field	52.0%	22.1%	4.9%	1.7%	4.1%	7.4%	5.3%		2.1%	0.4%	
Average Cost Per Job.	$ 2,505	$ 3,725	$ 6,360	$ 1,150	$ 2,665	$ 8,605	$ 2,410		$16,985	$ 3,845	
	(S PS F)*	(S PS F)	(S PS F)	(S PS F)	(S PS F)	(S PS F)	(S PS F)		(S PS F)	(S PS F)	
Analysis of Results, Jobs	52 59 16	18 59 7	2 7 3	0 2 2	6 1 3	6 9 3	4 6 3		2 3 0	0 1 0	
Analysis of Results, Percent	41% 46% 13%	33% 54% 13%	17% 58% 25%	0% 50% 50%	60% 10% 30%	33% 50% 17%	31% 46% 23%		40% 60% 0%	0% 100% 0%	
WASSON											
Number of Jobs by Type	66	5	12	10	1			2			
Percent of Total Jobs in Field	68.8%	5.2%	12.5%	10.4%	1.0%			2.1%			
Average Cost Per Job	$ 1,890	$ 9,325	$17,975	$ 200	No Data			$ 835			
	(S PS F)	(S PS F)	(S PS F)	(S PS F)	(S PS F)			(S PS F)			
Analysis of Results, Jobs	44 14 8	3 1 1	8 4 0	4 0 6	0 0 1			0 1 1			
Analysis of Results, Percent	67% 21% 12%	60% 20% 20%	67% 33% 0%	40% 0% 60%	0% 0% 100%			0% 50% 50%			
SLAUGHTER											
Number of Jobs by Type	5			17	14			1			
Percent of Total Jobs in Field	13.5%			45.9%	37.9%			2.7%			
Average Cost Per Job.	$ 3,315			$ 270	$ 2,545			$ 4,050			
	(S PS F)			(S PS F)	(S PS F)			(S PS F)			
Analysis of Results, Jobs	4 1 0			9 3 5	12 1 1			1 0 0			
Analysis of Results, Percent	80% 20% 0%			53% 18% 29%	86% 7% 7%			100% 0% 0%			
FULLERTON											
Number of Jobs by Type	25										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 2,680										
	(S PS F)										
Analysis of Results, Jobs	8 13 4										
Analysis of Results, Percent	32% 52% 16%										
MONUMENT											
Number of Jobs by Type	7	1	11		3	1					
Percent of Total Jobs in Field	30.5%	4.3%	47.8%		13.1%	4.3%					
Average Cost Per Job	$ 1,540	$ 3,596	$ 7,575		$ 2,200	$ 5,500					
	(S PS F)*	(S PS F)	(S PS F)		(S PS F)	(S PS F)					
Analysis of Results, Jobs	2 2 3	1 0 0	8 2 1		0 1 2	1 0 0					
Analysis of Results, Percent	29% 29% 42%	100% 0% 0%	73% 18% 9%		0% 33% 67%	100% 0% 0%					
EUNICE											
Number of Jobs by Type	11	1	3	1	2	1					
Percent of Total Jobs in Field	58.0%	5.2%	15.8%	5.2%	10.5%	5.3%					
Average Cost Per Job	$ 1,330	$ 4,800	$ 3,085	$ 195	No Data	$ 6,255					
	(S PS F)	(S PS F)	(S PS F)	(S PS F)	(S PS F)	(S PS F)					
Analysis of Results, Jobs	4 6 1	1 0 0	0 2 1	0 1 0	1 0 1	1 0 0					
Analysis of Results, Percent	36% 55% 9%	100% 0% 0%	0% 67% 33%	0% 100% 0%	50% 0% 50%	100% 0% 0%					
HOBBS											
Number of Jobs by Type	14		1				1	2			
Percent of Total Jobs in Field	77.8%		5.6%				5.6%	11.0%			
Average Cost Per Job	$ 3,470		$14,500				$ 1,000	$21,500**			
	(S PS F)		(S PS F)				(S PS F)	(S PS F)			
Analysis of Results, Jobs	13 0 1		1 0 0				0 1 0	2 0 0			
Analysis of Results, Percent	93% 0% 7%		100% 0% 0%				0% 100% 0%	100% 0% 0%			
NORTH COWDEN											
Number of Jobs by Type	5		3							1	
Percent of Total Jobs in Field	55.6%		33.3%							11.1%	
Average Cost Per Job	$ 4,520		$ 8,765							$ 5,900	
	(S PS F)		(S PS F)							(S PS F)	
Analysis of Results, Jobs	3 2 0		3 0 0							0 1 0	
Analysis of Results, Percent	60% 40% 0%		100% 0% 0%							0% 100% 0%	

	TOTAL JOBS ALL TYPES
Number of Jobs in Field	244
Percent of All Jobs - All Fields	48.9%
Average Cost Per Job	$ 3,510
	(S PS F)
Analysis of Results, Jobs	90 117 37
Analysis of Results, Percent	37% 48% 15%
Number of Jobs in Field	96
Percent of All Jobs - All Fields	19.1%
Average Cost Per Job	$ 2,545
	(S PS F)
Analysis of Results, Job	59 20 17
Analysis of Results, Percent	61% 21% 18%
Number of Jobs in Field	37
Percent of All Jobs All Fields	7.4%
Average Cost Per Job	$ 2,780
	(S PS F)
Analysis of Results, Jobs	26 5 6
Analysis of Results, Percent	70% 14% 16%
Number of Jobs in Field	25
Percent of All Jobs - All Fields	4.9%
Average Cost Per Job	$ 2,680
	(S PS F)
Analysis of Results, Jobs	8 13 4
Analysis of Results, Percent	32% 52% 16%
Number of Jobs in Field	23
Percent of All Jobs - All Fields	4.5%
Average Cost Per Job	$ 3,742
	(S PS F)
Analysis of Results, Jobs	12 5 6
Analysis of Results, Percent	52% 22% 26%
Number of Jobs in Field	19
Percent of All Jobs - All Fields	3.8%
Average Cost Per Job	$ 2,025
	(S PS F)
Analysis of Results, Jobs	7 9 3
Analysis of Results, Percent	37% 47% 16%
Number of Jobs in Field	18
Percent of All Jobs - All Fields	3.6%
Average Cost Per Job	$ 6,445
	(S PS F)
Analysis of Results, Jobs	16 1 1
Analysis of Results, Percent	88% 6% 6%
Number of Jobs in Field	9
Percent of All Jobs - All Fields	1.8%
Average Cost Per Job	$ 6,087
	(S PS F)
Analysis of Results, Jobs	6 3 0
Analysis of Results, Percent	67% 33% 0%

* S-Success PS - Partial Success F- Failure ** Average cost high because of two abnormally high cost jobs.

Table 1 (Continued). Analysis of all GOR repair jobs by types of jobs.

FIELD	FORMATION PACKERS	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PER. IN CASING PERFS.	COMBINATION JOBS	MISC. JOBS	TOTAL JOBS ALL TYPES
SEMINOLE											
Number of Jobs by Type	1		1								
Percent of Total Jobs in Field	50.0%		50.0%								
Average Cost Per Job	$ 1,500		$ 1,500								
	(S PS F)		(S PS F)								
Analysis of Results, Jobs	1 0 0		1 0 0								
Analysis of Results, Percent	100% 0% 0%		100% 0% 0%								
SOUTH COWDEN											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										
TUBB											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										
WARREN											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										
WASSON											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										
WEST TEXAS											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										
WILDCAT											
Number of Jobs by Type	1										
Percent of Total Jobs in Field	100%										
Average Cost Per Job	$ 1,500										
	(S PS F)										
Analysis of Results, Jobs	1 0 0										
Analysis of Results, Percent	100% 0% 0%										

	TOTAL JOBS ALL TYPES
Number of Jobs in Field	2
Percent of All Jobs - All Fields	0.4%
Average Cost Per Job	$ 1,250
	(S PS F)
Analysis of Results, Jobs	1 1 0
Analysis of Results, Percent	50% 50% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%
Number of Jobs in Field	1
Percent of All Jobs - All Fields	0.2%
Average Cost Per Job	$ 1,500
	(S PS F)
Analysis of Results, Jobs	1 0 0
Analysis of Results, Percent	100% 0% 0%

* S-Success PS - Partial Success F- Failure ** Average cost high because of two abnormally high cost jobs.

Table 1 (Continued). Analysis of all GOR repair jobs by types of jobs.

FIELD	FORMATION PACKERS	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PER. IN CASING PERFS	COMBINATION JOBS	MISC. JOBS	TOTAL JOBS ALL TYPES
KEYSTONE - HOLT											
Number of Jobs by Type		7	1								Number of Jobs in Field 8
Percent of Total Jobs in Field		87.5%	12.5%								Percent of All Jobs - All Fields 1.6%
Average Cost Per Job		No Data	No Data								Average Cost Per Job No Data
Analysis of Results, Jobs		S PS F: 3 3 1	S PS F: 1 0 0								S PS F: 4 3 1
Analysis of Results, Percent		43% 43% 14%	100% 0% 0%								Analysis of Results, Percent 50% 37% 13%
DRINKARD											
Number of Jobs by Type	3	1								1	Number of Jobs in Field 5
Percent of Total Jobs in Field	60%	20%								20%	Percent of All Jobs - All Fields 1.0%
Average Cost Per Job	$ 2,335	No Data								No Data,	Avefage Cost Per Job $ 2,335
Analysis of Results, Jobs	S PS F: 1 2 0	S PS F: 1 0 0								S PS F: 0 1 0	S PS F: 2 3 0
Analysis of Results, Percent	33% 67% 0%	100% 0% 0%								0% 100% 0%	Analysis of Results, Percent 40% 60% 0%
EVELAND											
Number of Jobs by Type	2	1									Number of Jobs in Field 3
Percent of Total Jobs in Field	66.7%	33.3%									Percent of All Jobs - All Fields 0.6%
Average Cost Per Job	$ 2,675	No Data									Average Cost Per Job $ 2,675
Analysis of Results, Jobs	S PS F: 1 0 1	S PS F: 1 0 0									S PS F: 2 0 1
Analysis of Results, Percent	50% 0% 50%	100% 0% 0%									Analysis of Results, Percent 67% 0% 33%
FUHRMAN - MASCHO											
Number of Jobs by Type		3									Number of Jobs in Field 3
Percent of Total Jobs in Field		100%									Percent of All Jobs - All Fields 0.6%
Average Cost Per Job		$ 5,790									Average Cost Per Job $ 5,790
Analysis of Results, Jobs		S PS F: 3 0 0									S PS F: 3 0 0
Analysis of Results, Percent		100% 0% 0%									Analysis of Results, Percent 100% 0% 0%
WEST SEMINOLE											
Number of Jobs by Type		2									Number of Jobs in Field 2
Percent of Total Jobs in Field		100%									Percent of All Jobs - All Fields 0.4%
Average Cost Per Job		$ 8,000									Average Cost Per Job $ 8,000
Analysis of Results, Jobs		S PS F: 2 0 0									S PS F: 2 0 0
Analysis of Results, Percent		100% 0% 0%									Analysis of Results, Percent 100% 0% 0%
BOWERS											
Number of Jobs by Type		1									Number of Jobs in Field 1
Percent of Total Jobs in Field		100%									Percent of All Jobs - All Fields 0.2%
Average Cost Per Job		$ 9,842									Average Cost Per Job $ 9,842
Analysis of Results, Jobs		S PS F: 0 1 0									S PS F: 0 1 0
Analysis of Results, Percent		0% 100% 0%									Analysis of Results, Percent 0% 100% 0%
COOPER-JAL											
Number of Jobs by Type	1										Number of Jobs in Field 1
Percent of Total Jobs in Field	100%										Percent of All Jobs - All Fields 0.2%
Average Cost Per Job	$ 935										Average Cost Per Job $ 935
Analysis of Results, Jobs	S PS F: 0 1 0										S PS F: 0 1 0
Analysis of Results, Percent	0% 100% 0%										Analysis of Results, Percent 0% 100% 0%
YATES											
Number of Jobs by Type	1										Number of Jobs in Field 1
Percent of Total Jobs in Field	100%										Percent of All Jobs - All Fields 0.2%
Average Cost Per Job	$10,306										Average Cost Per Job $10,306
Analysis of Results, Jobs	S PS F: 1 0 0										S PS F: 1 0 0
Analysis of Results, Percent	100% 0% 0%										Analysis of Results, Percent 100% 0% 0%

* S - Success PS - Partial Success F - Failure

Table 1 (Continued). Analysis of all GOR repair jobs by types of jobs.

FIELD	FORMATION PACKERS	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PER. IN CASING PERFS	COMBINATION JOBS	MISC. JOBS,	TOTAL JOBS ALL TYPES
SOUTH EUNICE											
Number of Jobs by Type					1						1
Percent of Total Jobs in Field					100%						0.2%
Average Cost Per Job					No Data						No Data
Analysis of Results, Jobs (S PS F)*					1 0 0						1 0 0
Analysis of Results, Percent					100% 0% 0%						100% 0% 0%
SEMINOLE											
Number of Jobs by Type			1								1
Percent of Total Jobs in Field			100%								0.2%
Average Cost Per Job			$ 9,855								$ 9,855
Analysis of Results, Jobs (S PS F)			1 0 0								1 0 0
Analysis of Results, Percent			100% 0% 0%								100% 0% 0%
PADDOCK											
Number of Jobs by Type		1									1
Percent of Total Jobs in Field		100%									0.2%
Average Cost Per Job		$10,000									$10,000
Analysis of Results, Jobs (S PS F)		1 0 0									1 0 0
Analysis of Results, Percent		100% 0% 0%									100% 0% 0%
KEYSTONE - ELLENBURGER											
Number of Jobs by Type		1									1
Percent of Total Jobs in Field		100%									0.2%
Average Cost Per Job		$35,000									$35,000
Analysis of Results, Jobs (S PS F)		1 0 0									1 0 0
Analysis of Results, Percent		100% 0% 0%									100% 0% 0%
TIPPETT											
Number of Jobs by Type		1									1
Percent of Total Jobs in Field		100%									0.2%
Average Cost Per Job		$30,000									$30,000
Analysis of Results, Jobs (S PS F)*		1 0 0									1 0 0
Analysis of Results, Percent		100% 0% 0%									100% 0% 0%
MEARS											
Number of Jobs by Type						1					1
Percent of Total Jobs in Field						100%					0.2%
Average Cost Per Job						$ 4,000					$ 4,000
Analysis of Results, Jobs (S PS F)						0 1 0					0 1 0
Analysis of Results, Percent						0% 100% 0%					0% 100% 0%
ABELL-PERMIAN											
Number of Jobs by Type								1			1
Percent of Total Jobs in Field								100%			0.2%
Average Cost Per Job								No Data			No Data
Analysis of Results, Jobs (S PS F)								1 0 0			1 0 0
Analysis of Results, Percent								100% 0% 0%			100% 0% 0%

* S - Success PS - Partial Success F - Failure

Controlled Water Loss!

HELP SOLVE YOUR DRILLING PROBLEMS WITH

DRISCOSE*

Excessive water loss can cost you time and money! Control it with efficient, versatile Driscose!

4 CC OR LESS is a typical water loss when using 1 to 1½ pounds of Driscose per barrel of uncontaminated mud. Highly successful, too, when salt or calcium is present. 1 pound of Driscose per barrel of calcium contaminated mud has cut water loss from 74 to 9 cc! Complete data on request.

LESS TIME OUT for stuck drill stems and other delays caused by drilling muds. Driscose base muds form thin, strong filter cakes. Low bentonitic dispersion in Driscose mud minimizes wetting and washing actions, thereby resulting in a hole very near to bit gage size.

OTHER SAVINGS! Less need for weighting materials cuts down need for storage space. Transportation and handling expenses reduced, too. No special equipment required for Driscose. Add it through regular hopper. It's soluble in hot or cold water.

COSTS NOTHING TO FIND OUT how much you can save with Driscose! Discuss your drilling mud problems with our mud engineers . . . without any obligation to you. You can order Driscose through your regular drilling mud dealer in 50-pound, 6-ply, waterproof bags.

***DRISCOSE** *is a trademark for Sodium Carboxymethylcellulose*

DRILLING SPECIALTIES COMPANY

BARTLESVILLE, OKLAHOMA

Table 1 (Continued). Analysis of all GOR repair jobs by types of jobs.

FIELD	FORMATION PACKERS	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PKR. IN CASING PERFS	COMBINATION JOBS	MISC. JOBS	TOTAL JOBS ALL TYPES
TXL - DEVONIAN											
Number of Jobs by Type								1			Number of Jobs in Field 1
Percent of Total Jobs in Field								100%			Percent of All Jobs - All Fields 0.2%
Average Cost Per Job								$ 6,236			Average Cost Per Job $ 6,236
Analysis of Results, Jobs (S PS F)								0 1 0			Analysis of Results, Jobs 0 1 0
Analysis of Results, Percent								0% 100% 0%			Analysis of Results, Percent 0% 100% 0%
TOTAL JOBS ALL FIELDS											TOTAL JOBS ALL TYPES - ALL FIELDS
Number of Jobs by Type	267	79	44	32	31	21	14	7	5	3	Total - All Jobs 503
Percent of All Jobs	53.0%	15.7%	8.7%	6.4%	6.2%	4.2%	2.8%	1.4%	1.0%	0.6%	Percent of All Jobs 100%
Average Cost Per Job	$ 2,435	$ 5,499	$ 8,657	$ 356	$ 4,260	$ 8,102	$ 2,307	$ 9,158**	$16,985	$ 4,873	Average Cost Per Job $ 3,570
Analysis of Results, Jobs (S PS F)*	133 100 34	36 34 9	24 15 5	13 6 13	20 3 8	8 10 3	4 7 3	4 2 1	2 3 0	0 3 0	Analysis of Results, Jobs 244 183 76
Analysis of Results, Percent	50% 37% 13%	46% 43% 11%	55% 34% 11%	41% 19% 40%	64% 10% 26%	38% 48% 14%	29% 50% 21%	57% 29% 14%	40% 60% 0%	0% 100% 0%	Analysis of Results, Percent 49% 36% 15%

Table 2. Analysis of GOR repair jobs by date.

JOBS PRIOR TO JANUARY 1, 1946

	FORMATION PACKER	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PKR. IN CASING PERFS.	COMBINATION JOBS	MISCELLANEOUS JOBS
Number of Jobs	113	53	20	5	12	6	14	None	4	
Percent of Total Jobs	49.7%	23.4%	8.8%	2.2%	5.3%	2.6%	6.2%		1.8%	
Average Cost Per Job	$ 1.645	$ 3,675	$ 7,035	$ 769	$ 2,620	$ 4,290	$ 2,305		$12,977	
Analysis of Results, Jobs (S PS F)	44 51 18	19 28 6	8 9 3	1 2 2	6 1 5	2 2 2	4 7 3		2 2 0	
Analysis of Results, Percent	39% 45% 16%	36% 53% 11%	40% 45% 15%	20% 40% 40%	50% 8% 42%	33.3% 33.3% 33.3%	29% 50% 21%		50% 50% 0%	

TOTAL NUMBER OF JOBS PRIOR TO JANUARY 1, 1946 227 (45.2% of all jobs)
AVERAGE COST PER JOB $ 2,730

ANALYSIS OF RESULTS, JOBS (S PS F) 86 102 39
ANALYSIS OF RESULTS, PERCENT 38% 45% 17%

JOBS AFTER JANUARY 1, 1946

	FORMATION PACKER	CEMENT SQUEEZE	LINERS	MECHANICAL DEVICES	SELECTIVE ACIDIZATION	PLASTIC SQUEEZE	PLUGGING AGENTS	PROD. PKR. IN CASING PERFS.	COMBINATION JOBS	MISCELLANEOUS JOBS
Number of Jobs	154	26	24	27	19	15	None	7	1	3
Percent of Total Jobs	55.8%	9.4%	8.7%	9.8%	6.9%	5.4%		2.5%	0.4%	1.1%
Average Cost Per Job	$ 3,079	$10,545	$14,740	$ 280	$ 5,545	$ 9,735		$ 9,160**	$25,000	$ 4,875
Analysis of Results, Jobs (S PS F)	89 49 16	17 6 3	16 6 2	12 4 11	14 2 3	6 8 1		4 2 1	0 1 0	0 3 0
Analysis of Results. Percent	58% 32% 10%	65% 23% 12%	67% 25% 8%	45% 15% 41%	74% 10% 16%	40% 53% 7%		57% 29% 14%	0% 100% 0%	0% 100% 0%

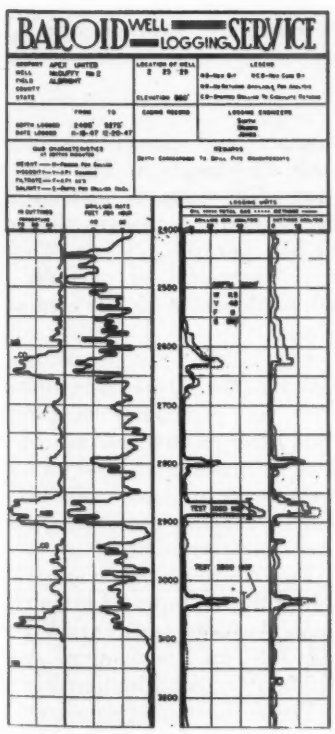
TOTAL NUMBER OF JOBS AFTER JANUARY 1, 1946 276 (54.8% of all jobs)
AVERAGE COST PER JOB $ 4,360

ANALYSIS OF RESULTS, JOBS (S PS F) 158 81 37
ANALYSIS OF RESULTS, PERCENT 57% 29% 14%

* S - Success PS - Partial Success F - Failure ** Average cost high because of two abnormally high cost jobs.

BAROID Well Logging Service

MUD ANALYSIS AND CUTTING ANALYSIS COMBINED IN ONE LOG



Makes Wildcats Purr!

Every wildcat is an exciting new adventure. Each foot of hole drilled holds promise of production or perhaps great disappointment. BAROID WELL LOGGING SERVICE is designed to remove uncertainty as the bit goes down. Oil and gas shows are accurately located. Porosity and permeability of the formations are indicated. Coring can be controlled so only necessary cores need be taken.

These advantages mean faster, more efficient drilling and lowered drilling costs. Operators can tell you that the BAROID Logging Crew on the job really makes a wildcat purr. Your BAROID representative will be glad to give you complete details. Call him at the nearest address below.

Alexandria, La.	Phone 8630
New Orleans	GAlvez 7397
Corpus Christi	3-3262
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Houston	CEntral 9371
Los Angeles	Michigan 1381
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* S - Success PS - Partial Success F - Failure ** Average cost high because of two abnormally high cost jobs.

main classifications or types of jobs, as follows:

1. *Formation Packers:* This classification included all types of formation packers used to exclude gas. In conjunction with some packers, sealing material was used and some wells were cleaned out, deepened, and acidized.

2. *Cement Squeeze:* This classification included all jobs in which the gas-bearing formation was squeezed with cement, no matter what the mechanics of the job were. In some cases cement was squeezed into casing perforations and in other cases into the open hole, after the oil-bearing formation had been protected by some type of plug. After the gas was shut off, later work consisted of perforating and/or acidizing.

3. *Liners:* This classification included all workovers in which a liner was cemented through the gas-bearing formation. In some wells the liner was cemented below the gas-oil contact and an open-hole completion made below, while in others the liner was cemented at or near the bottom of the hole and perforated for completion. After the gas was shut off, acid was used in the majority of the wells.

4. *Mechanical Devices:* This classification covered all types of mechanical devices used for the purpose of reducing the gas-oil ratio of a well. It included such devices as time-cycle controllers or intermitters, pressure-controlled intermitters, flow valves, and bottom-hole chokes.

5. *Selective Acidization:* This type covered any job or device in which the oil zone was selectively acidized to the exclusion of the gas zone. Included were jobs in which the placement of acid was controlled by a packer, a pilot and two-pump method, or any of various other methods of controlling or placing acid. In addition, some of these wells were deepened, perforated, or shot with nitroglycerin.

6. *Plastic Squeeze:* This classification included all jobs in which plastic was squeezed or forced into a gas-bearing formation. Additional work performed on wells of this classification included cleaning out, deepening, and acidizing.

7. *Plugging Agents:* This classification included all jobs in which either a combination of sodium silicate and sulfuric acid or emulsified oil was forced into gas-bearing horizons to provide a permeability block. These types of plugging agents, as shown by the data analyzed, were used prior to 1945. Acidization and shooting with nitroglycerin were used in conjunction with this type of job.

FIG. 2. Right, Summary of all repair jobs.

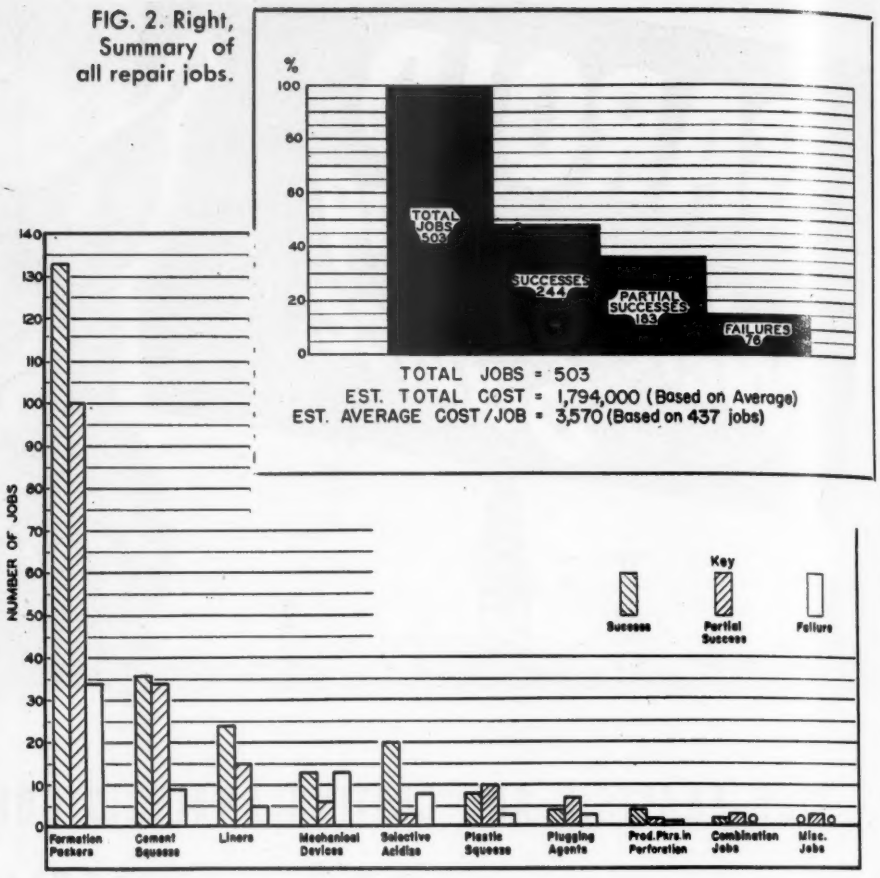


FIG. 3. Analysis of comparative results by types of jobs.

8. *Production Packer in Casing Perforations:* This type of job included all those jobs on wells that were producing through perforations and in which a production packer was set in or between the perforations for the purpose of excluding an upper gas-bearing formation.

9. *Combination Type:* This type of job covers a combination of two or more of any of the aforementioned classifications and was usually the result of a failure or partial failure of one type of repair job that necessitated the use of an additional method on the same workover.

10. *Miscellaneous Type:* This type includes cleanouts, deepening, and perforating, which was not done in conjunction with any of the aforementioned types of work.

Statistical Results of Survey

A total of 503 questionnaires completed in usable form, covering 24 fields in West Texas and New Mexico, were received from operators. These questionnaires cover the period from December, 1932, to August, 1949. The jobs were classified as: (1) Successful, (2) partially successful, or (3) failures, on the basis of the criteria previously mentioned in the paper.

Fig. 2 shows the breakdown into number and percentage of jobs in each classification. The total cost of these 503 jobs is estimated to be $1,794,000, or an over-all average of $3,570 per job. Nearly 85 per cent were successful or partially successful, while about 15 per cent were failures.

Fig. 3 shows a breakdown of all jobs into the 10 main classifications of jobs as previously discussed and shows the relative success of each. It is to be considered, however, that these classifications cover all fields with widely varying reservoir and formation characteristics.

Fig. 4 shows the average cost per job of the 10 types of main classifications. Average costs varied from $356 per job for mechanical devices to $16,985 for combination jobs.

Fig. 5 shows comparative results of all work performed in each of 10 fields with the greatest number of jobs. It can be seen that the chances for success are better in some fields than in others.

Fig. 6 shows the average cost of all jobs in each of the 10 major fields mentioned above. Cost data were available on 447 out of 503 jobs.

Fig. 7 shows the breakdown of comparative results of jobs before and

(Continued on Page B-35)

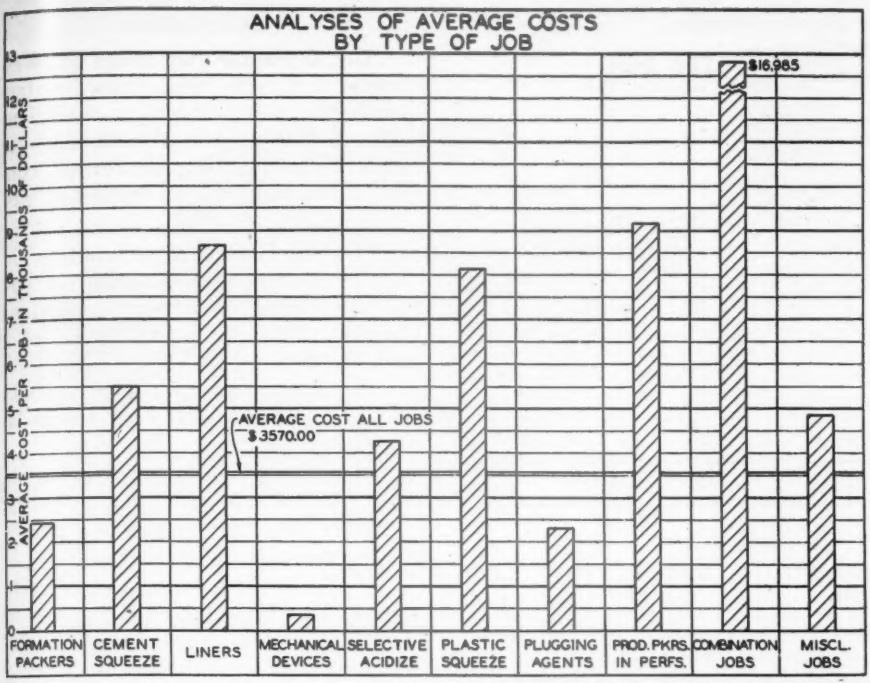


FIG 4.

(Continued from Page B-18)

after January 1, 1946. Two hundred and twenty-seven jobs were done before January 1, 1946 and 276 were done afterwards. The over-all average cost per job before January 1, 1946 was $2,730 and after that time was $4,360. The fact that the average cost per job was approximately 60 per cent higher after January 1, 1946 is at least partially a reflection of higher costs of doing the same work. The number of successful jobs increased from 38 per cent to 57 per cent after January 1, 1946. The failures amounted to 17 per cent before January 1, 1946 and 14 per cent after that date. This information is summarized in Table 2.

A total of 144 successful jobs of all types in all fields which were considered to have complete and adequate information were analyzed as to gas-oil ratios before and after workovers and as to life, as previously defined. It was found that the arithmetic average of gas-oil ratios before workovers was 12,700, and averaged 1230 cu ft per barrel of oil afterward for an average life of between 2½ and 3 years. It again should be pointed out that the gas-oil ratios both before and after workovers are arithmetic averages and include some extremely high gas-

FIG. 5. Analyses of comparative results by fields.

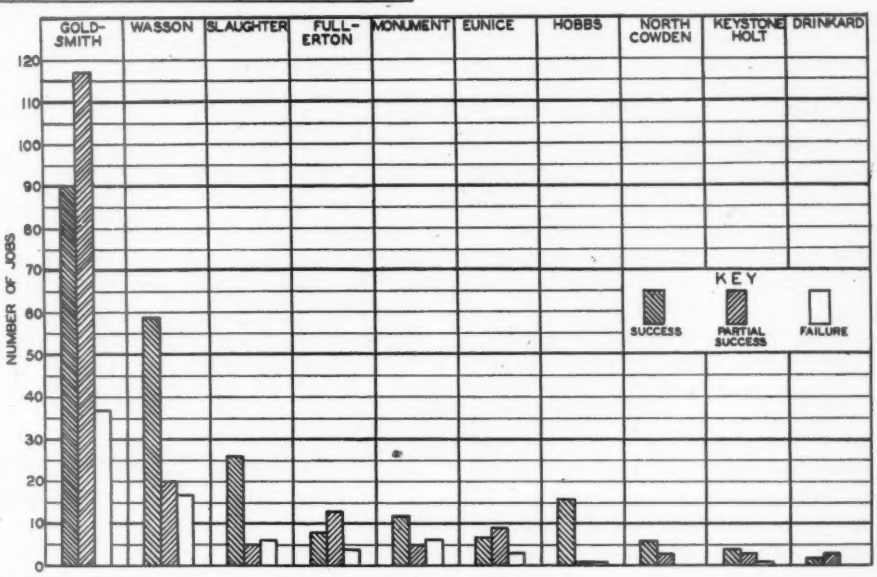
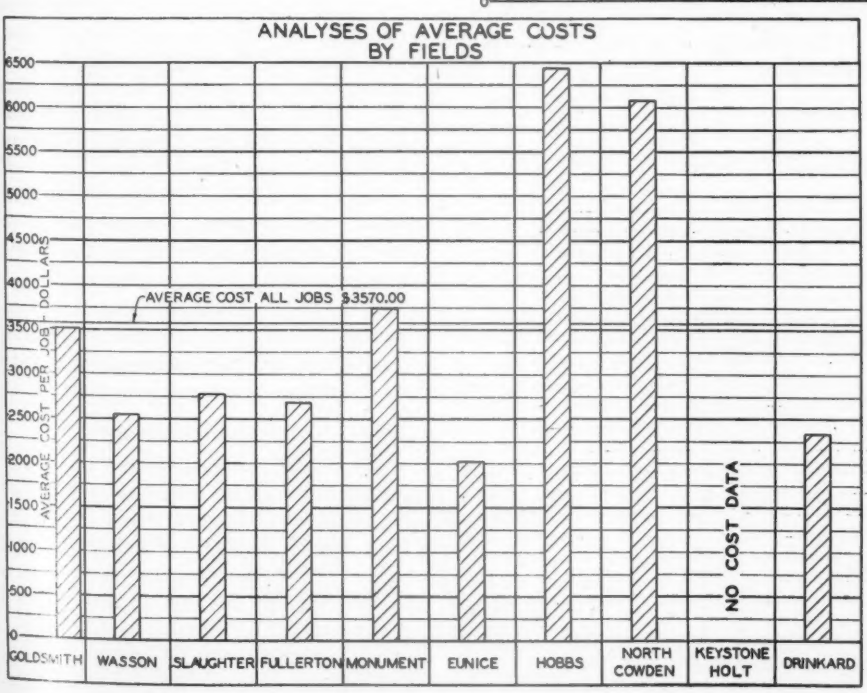


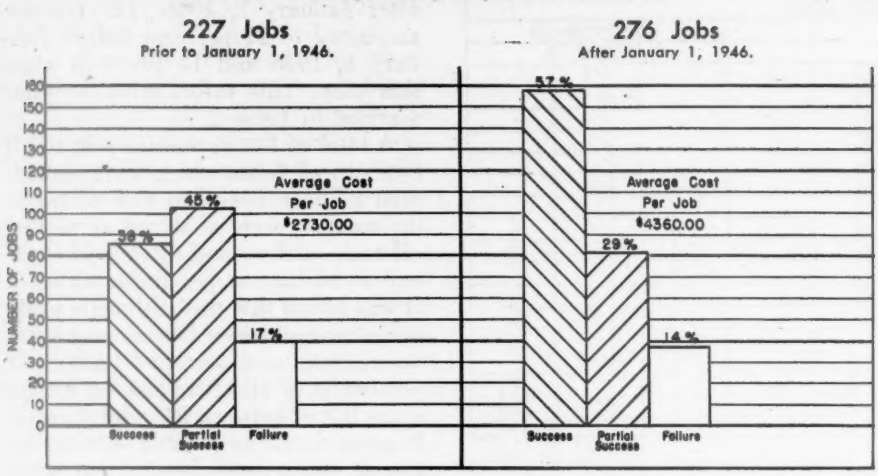
FIG. 6.



oil ratios before repair work. Fourteen of the 144 successful jobs considered had gas-oil ratios over 25,000 cu ft per barrel of oil before workovers. Four of these 14 wells had ratios over 50,000 cu ft per barrel of oil. If the 14 wells with gas-oil ratios in excess of 25,000 cu ft per barrel of oil are not considered, the arithmetic average gas-oil ratios before repair work would be 7600 cu ft per barrel of oil.

It was indicated by a rough analysis of a representative number of successful jobs of each type that cement squeeze, plugging-agent squeeze, and liner jobs have the longest life of any type of repair work considered in this report. These types of jobs probably have an average life of over three years. The data indicates, further, that plastic squeeze and formation-packer jobs probably have an average life of over two years, while selective acidizing jobs provide bene-

FIG. 7. Analyses of comparative results.



ficial results for a period of only one year, or less.

Fig. 8 shows the analyses of failures. Seventy-six out of 503 jobs, or approximately 15 per cent, were failures. The reason for failure of nearly one-half the jobs was unknown because of insufficient information or lack of familiarity of the authors with the conditions prevailing in the particular well or field. Twenty-three and one-half per cent of the unsuccessful jobs were the result of mechanical failures, such as rupturing of packer rubber, losing cement bond after acidizing, etc. Mechanical failures were generally apparent from the data on questionnaire forms or were specifically mentioned by the operator as the cause of failure. Improper application was the cause of 16 per cent of the failures. Generally, these were in wells in which the gas-oil contact or other subsurface conditions were not known at the time of the work. Reservoir conditions accounted for 12 per cent of the failures. Unless specifically mentioned by the operator in the questionnaire forms, interpretations of this cause of failure were made by the authors from their knowledge of reservoir characteristics of the various fields. These, of course, were limited to fields with which one or both of the authors were familiar. In the opinion of the authors, a large number of those jobs for which the reason for failure is listed as unknown could be properly attributed to reservoir conditions.

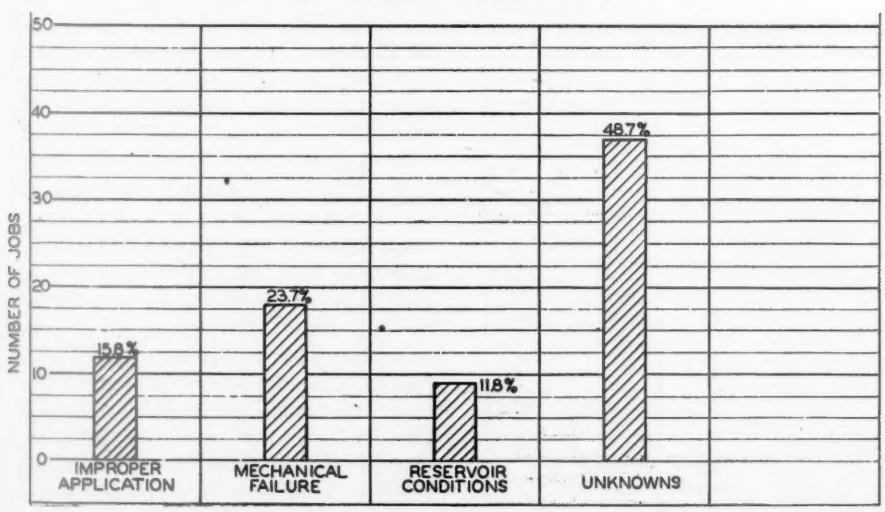
Table 1 is a summary of statistical information taken from the questionnaire forms. This information is classified by types of jobs and by fields, showing the results and average costs. For example, if specific information is desired concerning a packer job at Wasson, the tabulation shows the following information:

(1) Packer jobs comprised 69 per cent of the total jobs in the field.

(2) Forty-four out of 66 jobs, or 67 per cent, were rated *successes;* 21 per cent, *partial successes;* and 12 per cent, *failures.*

(3) Average cost per job was $1,890.

FIG. 8. Analyses of failures—76 jobs.



Conclusions

The limestone pay zones in West Texas and New Mexico have certain characteristics that lead to conditions favorable to successful control of gas and others that impose certain conditions unfavorable to control of gas.

Favorable conditions are:

(1) Thick gross oil columns.

(2) Heterogeneous nature of pay zones, usually containing impervious layers, although these may be of a minor nature.

(3) Definite impervious streaks separating the gas and oil accumulations.

(4) Competent nature of impermeable limestone or dolomite, providing suitable packer seats or shutoff points.

Unfavorable conditions are:

(1) Thin oil columns immediately overlaid by large gas caps.

(2) Vertical permeability along fracture planes preventing an effective seal.

(3) Depletion of low permeable reservoirs to a pressure below the bubble point which results in increased gas saturation, lessened permeability to oil, and increased permeability to gas.

(4) Expanding gas caps resulting in a continuous lowering of gas-oil contacts.

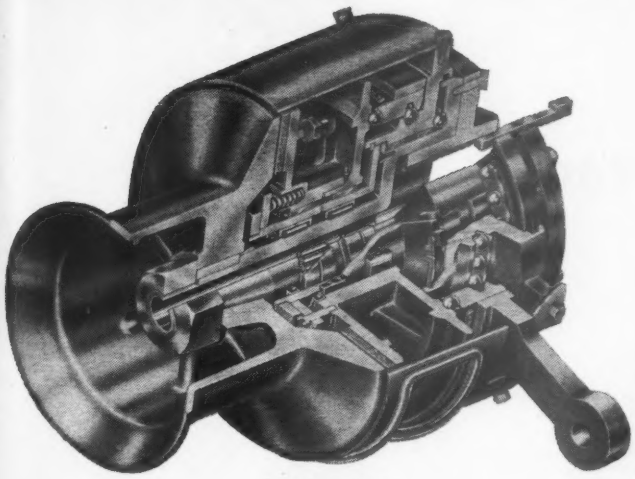
It can be concluded that where conditions are favorable for control of gas, as outlined above, definite benefits result from gas-oil ratio repair work. This is true in the central portion of the Wasson field, for example, where a thick gross oil column is found. A closed or depletion-type field, however, may have an expanding gas cap, which may necessitate continuing workovers as the gas cap expands and the gas-oil contact lowers. Some of the most successful and permanent repair work has been done in a field such as the Hobbs field, where the uppermost main producing horizon is gas bearing and is separated from the underlying oil zone by an impervious layer. Packer jobs have been successful in excluding the upper gas for as long as 13 years.

When the conditions are found to be unfavorable for control of gas, as outlined above, the success of repair work becomes extremely uncertain.

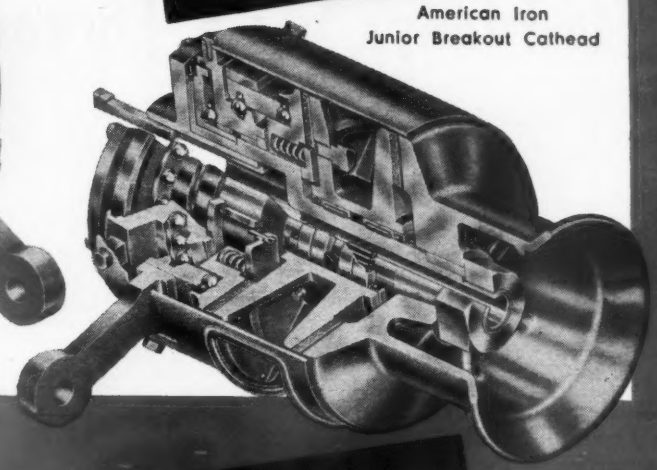
Acknowledgment

The excellent cooperation of operators in West Texas and New Mexico in completing the questionnaire forms from which data for the report were taken is hereby acknowledged. Acknowledgment is given also to the management of Shell Oil Company, Inc., for permission to prepare and publish this paper. * * *

Designed for Small and Medium Drawworks



American Iron
Junior Makeup Cathead



American Iron
Junior Breakout Cathead

IT'S EASY to makeup and breakout tool joint connections with

AMERICAN IRON *Junior* FRICTION CATHEADS

Smaller in size—yet BIG in performance! That's the important news about the new American Iron Junior Friction Catheads. Their light weight and compactness make it possible for them to be safely and economically installed on any small or medium size rig.

As shown above, these catheads are designed with a simple ball-thread activating mechanism—the same as used in our larger friction catheads which have given such outstanding performance on larger drawworks. That's why our new Junior Friction Catheads produce the power that's needed to properly makeup and breakout all tool joint connections!

Check these outstanding advantages:

- **Smaller overall dimensions.**
- **More than enough power to facilitate proper makeup and breakout.**
- **Line pull closer to shaft bearing.**
- **Simple and quick installation.**
- **No adjustment necessary. Pre-adjusted at factory ready for mounting on shaft.**
- **No sensitive toggles to get out of adjustment.**
- **Non-crawling clutch drum.**
- **Instantaneous engagement and release without shock.**
- **Safety stationary guard that encloses all mechanism.**
- **Available with air or manual controls.**

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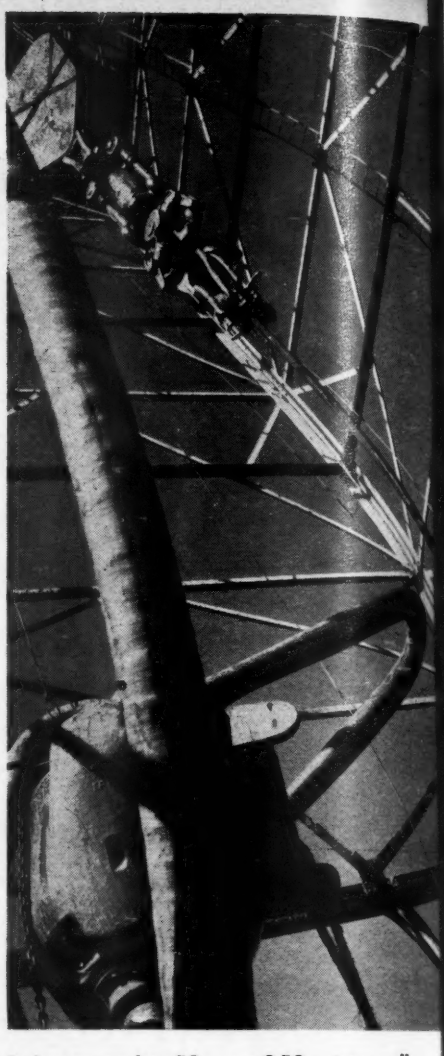
THE TOOL JOINT IS RUGGED BUT

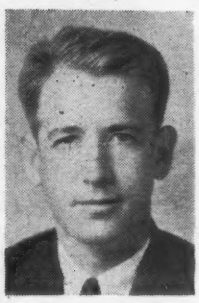
It Hangs by a Thread

FRANK BRIGGS



Below may be 50—or 250—tons, all hanging by the thread of the tool joint connection.

The Author



Frank Briggs was graduated from Rice Institute, Houston, Texas, with a BS degree in 1936. From that time until 1940 he was field engineer in Tulsa, Oklahoma, and Midland, Texas, for the S. M. Jones Company. In 1944 he joined Houston Oilfield Material Company in Houston as chief engineer, and last year, set up his own consulting office in Houston.

He is membership chairman for the petroleum division of AIME and a member of API and ASM.

FROM the groping, hesitant, personal brilliance of conception in the field of mechanics of Leonardo da Vinci to the combined, practical intelligence of the API committee on threads is a contrast unique in both time and progress. It was Leonardo, taking the crude spiral scratches on the bamboo poles of the Chinese and applying them to the log conduits of a newly installed sewerage system in the palace of the Medici, that first found a use for the threaded connection in the habits and life of the Western world. Apparently tiring of outside plumbing, and thumbing his nose at the tradition of the day, the Italian Pope commanded his artistic and mechanical genius temporary discontinuation of chapel decoration to seek a means of greater comfort for the royal personage. Using forming irons, heated in the bread ovens of the palace, the help of a motley crew of bakers and houseboys, who were the world's first plumber's, the spiral threads and mating grooves were burned into the ends of the hollow wooden lengths. Thread depth, pitch, and number were carefully observed; and thread compound containing mostly flour and water was used to insure a seal fit. The world remembers da Vinci for his great masterpieces of art; the sewerage system drew greater praise and reward from his liege lord than did the Mona Lisa.

Through the spheres of time, the success of this small beginning has been amplified until the threaded screw and connection is one of the most vital links in our civilization. So varied and diversified had become the types of threaded connectors that standardization became almost as important as the discovery. Following the example of that Human Engineer, Herbert Hoover, who took time from the stately problems of feeding and clothing the people of the world to aid in standardization of mechanical threads, the American Petroleum Institute accepted the responsibility of thread standardization for the petroleum industry. The performance of threaded equipment in the drilling for and producing of oil is a creditable testimony to the results of their job.

In the drilling for oil, the connections (tool joints) are the most vulnerable to mishandling, to service fatigue—to eventual failure. Much has been written and much improvement has been accomplished on increasing the service life of these members. One small, vital, but technical detail has often been shunted to the background as an admittedly weak, but-what-can-you-do-about-it, part—the thread. To the user of threaded equipment, an attempt is hereby made to explain thread elements, thread manufacture, thread identification and some of the causes and remedies of thread failure. These apply to tool joint threads only.

Manufacture

In thread terminology, "pitch" is the distance between a point on one thread to a corresponding point on the next thread measured parallel to the product axis.

"Lead" is the axial advance accomplished in one turn of the thread.

"Thread angle" is the angle included between the sides of the thread and is measured axially.

"Pitch diameter" refers to an imaginary cylinder, the surface of which would pass through the threads at such points as to make equal the width of the threads and the surfaces cut by the cylinder.

"Helix angle" is that angle made by the thread at the pitch diameter with a plane perpendicular to the axis.

"Crest" is the top of the thread and "root" is the bottom surface joining two sides of two adjacent threads.

All tool joint threads are incorporated on a tapering (conical) surface and are generally of two forms: A modified "V" and Acme shapes.

Tool joint threads are applied by one of three (or a combination of two) methods: Lathe cutting, milling, or grinding. Occasionally one of these methods may be used to rough out the thread and another employed to finish it.

Lathe cut threads far predominate in number—but not necessarily in

EXCLUSIVE

"Drilling takes a tough engine," says Driller C. L. Hendrick. "I've worked with almost every kind of engine. I'm partial to 'Cat' Diesels."

OIL drilling 24 hours a day is just about the toughest job you can give an engine. Yet here are three "Caterpillar" Diesels (D13000) which jointly have made 400,000 feet of hole—have piled up over 90,000 engine hours (more than 30,000 apiece)—and have been in the shop for overhaul *just ONCE*.

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The Carco Drilling Company, of Dallas, is the owner of the pictured engine trio powering a Unit U-10 drawworks, a 7¼ x 14 "Oilwell" mud pump, and an Emsco 128-foot derrick. Carco is 100% "Caterpillar" with two other "Caterpillar" Oilfield Engines on another rig. Regardless of the location of your "Cat" powered rigs, they have a "Caterpillar" dealer and his 24-hour-a-day parts and service facilities as close as the phone. *Standardize and economize with "Cat" Oilfield Engines.*

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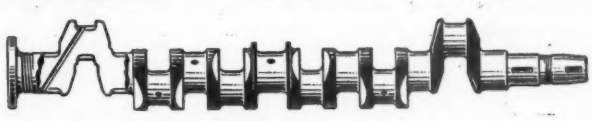

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TABLE 1. Dimensions and properties of most frequently used tool joints

Pipe, nominal size	2⅜				3½						4½						5½		
Outside diameter	3¼	4⅛	3¾	3⅛	4¼	4¼	4⅛	4¼	4¾	4	5⅛	5¾	6⅛	5½	6	5	6¼	6¼	7⅛
Inside diameter	1¼	2⅛	1¼	1¾	1⅞	1½	2⅛	1⅞	2⅞	2⅛	2¼	3	3¼	2½	3¼	2⅛	3¼	2¾	4⅛	3
No. of threads	5	4	4	4	4	5	5	4	4	4	5	5	4	4	4	4	4	4	4	4
Taper per foot	3	2	3½	2	2	3	3	2	2	2	3	3	2	3½	2	2	2	3	2	3½
Thread form	V-.040	V-.065	Acme	V-.065	V-.065	V-.040	V-.040	V-.065	Acme	V-.065	V-.040	V-.040	V-.065	Acme	V-.065	V-.065	V-.065	V-.050	V-.065	Acme
Tens. ST. at Y.P.*	514,250	478,340	477,500	337,120	538,500	727,400	690,000	627,000	588,000	478,340	1,262,000	1,017,000	999,000	1,086,000	957,050	627,000	999,000	1,779,000	1,341,000	1,769,000
Tors. ST. at Y.P.*	25,870	33,800	23,430	19,710	35,000	43,520	56,610	55,200	38,500	49,290	107,000	102,400	121,190	96,000	102,260	55,200	121,190	182,000	206,800	191,000
Cross sec. area	4.114	3.827	3.820	2.697	4.308	5.819	5.520	5.016	4.710	3.827	10.10	8.14	7.990	8.69	7.656	5.016	7.990	14.23	10.73	14.15
Box shoulder width	.344	.336	.351	.219	.445	.344	.289	.336	.336	.211	.406	.438	.406	.414	.547	.461	.468	.586	.461	.524

Pipe, nominal size	5½					6⅝													
Outside diameter	6¼	6¼	6¾	7	7⅛	6¾	6¾	6¾	7	7⅛	7⅝	7⅝	7⅝	7⅝	7⅝	8	8	8	8
Inside diameter	3¼	2½	2¾	3½	4½	3	2¾	2¾	3½	4½	3	3	3	3	4	3	3	4	4
No. of threads	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Taper per foot	2	2	3	2	2	2	2	3	2	2	2	2	3	2	2	2	3	2	2
Thread form	V-.065	V-.065	V-.050	V-.050	V-.065	V-.065	V-.065	V-.050	V-.050	V-.065	V-.065	V-.065	V-.050	V-.050	V-.065	V-.065	V-.050	V-.050	V-.065
Tens. ST. at Y.P.*	999,000	627,000	1,779,000	1,461,000	1,341,000	957,050	627,000	1,779,000	1,461,000	1,341,000	999,000	627,000	1,779,000	1,461,000	1,341,000	957,050	627,000	1,779,000	1,341,000
Tors. ST. at Y.P.*	121,190	55,200	182,000	185,000	206,800	102,260	55,200	182,000	185,000	206,800	121,190	55,200	182,000	185,000	206,800	102,260	55,200	182,000	185,000
Cross sec. area	7.990	5.016	14.23	11.69	10.73	7.656	5.016	14.23	11.69	10.73	7.990	5.016	14.23	11.69	10.73	7.656	5.016	14.23	11.69
Box shoulder width	.468	.461	.586	.547	.461	.547	.461	.586	.547	.461	.468	.461	.586	.547	.461	.547	.461	.586	.547

* Of Pin at Gage Point Y.P. of Material 125,000 P.S.I. Torsional Y.P. 93,750 P.S.I.

quality. The human element plays a large part in forming the thread as the product turns in the lathe and for this reason is less desirable than threads made by such pre-formed tools as the hob or the grinding wheel. In lathe cutting, the important features are the shape and angle of the cutting tool and the proper change gears of the machine. The cutting tool is shaped or planed from the desired helix angle. If this angle be "y," then

$$y = \frac{\text{lead of the thread}}{3.1416\ (d - a)}$$

where "a" is the depth of thread and "d" is the outside diameter of the product. The angle to set the shaper (planer) head may be found from

$$\tan x = \frac{\cos y \pm (\cot w \times \sin v \times \sin y)}{\cot w \times \cos v}$$

where "w" equals ½ thread angle and "v" is the front clearance angle.

After the cutting tool has been prepared, it is necessary to determine the change gears to use in the lathe for cutting a thread of a given pitch. This involves finding the number of threads per inch that are cut when gears of the same size are placed on the lead screw and spindle stud. This reference number can be determined from the index plate on the lathe; multiply this lathe "screw constant" by any trial number, say 4, to find the number of teeth in the gear for the spindle stud and multiply the threads per inch to be cut by the same trial number to obtain the number of teeth in the gear for the lead screw. This can be written:

$$\frac{\text{trial number} \times \text{screw constant}}{\text{trial number} \times \text{t.p.i. cut}} = \frac{\text{no. of teeth in gear on spindle stud}}{\text{no. of teeth in gear on lead screw}}$$

After shaping the tool and gearing the lathe for the proper pitch, the cutting of the thread to proper form rests with the lathe operator and his gages.

Thread milling is particularly adaptable to the manufacture of tool joints; it is the method used by most original manufacturers of the product. Thread reworking and products made by field shops are accomplished usually by the lathe process. In thread milling, two types of cutters (single and multiple) are used; the multiple cutter, commonly misnamed "hob," predominates. In use, the work is chucked in one slowly revolving head; the hob, driven at a faster speed, is fed into the work as it revolves in an opposing direction. The threads milled on the product take their shape from the cutting members of the hob. In threading either pin or box connections, the axis of the hob is parallel to

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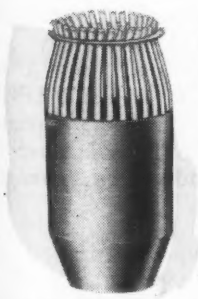

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when you're unloading a deep, wet well with a heavy fluid column. The "J" will bring out the heaviest column that can be safely handled—and, like the "L," it is fast-dropping going in and tight-sealing coming out.

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Established 1919 — Dallas, Texas U.S.A.

Milling a pin thread with the multiple cutter (hob); the product slowly revolves in an opposite direction to that of the cutter.

the axis of the tool joint; theoretically, this should produce interference between the thread and the cutter because each cutting edge is moving in a plane at right angle to the work axis while milling a thread groove of helical form. The defect is so slight as to be negligible in threads with lead angles under 3½ deg; in greater lead angles it is a factor to contend with while thread milling.

In one similar respect, thread milling may be compared with thread grinding; the use of rotating members wherein the shape of the thread to be formed is made thereon. Thread grinding is the process used in the making of the accurate "master" gages; also it has practically 100 per cent application in the forming of threads on extremely hard material. Certain mass production items, such as the pin connections on bits, may be economically produced by thread grinding.

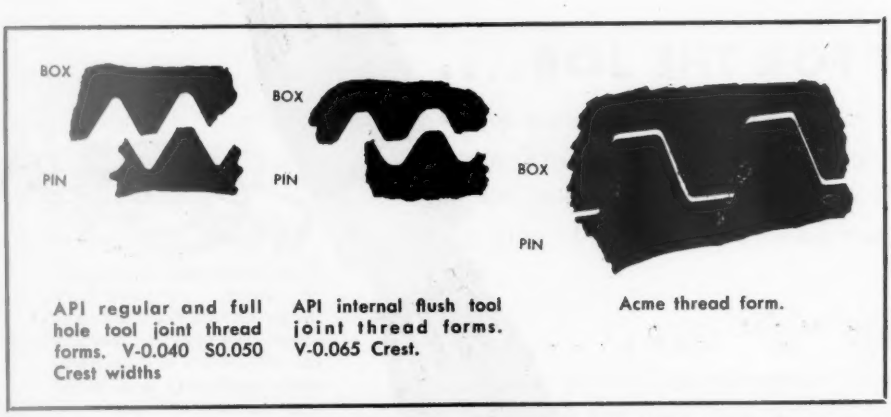
The wheels used for grinding threads on steel have an aluminous abrasive with either a resinoid or a vitrified bond. The wheels may be either single edge or with edges for roughing and finishing in one continuous operation. When grinding a thread, the wheel is inclined to align it with the thread groove. Wheel speeds are limited to 9500 surface feet per second for resinoid material and 6500 ft per minute for vitreous wheels.

Tool Joint Threads

Aside from the special patented thread forms, the tool joints used in the oil industry have either the "V" (API) or the Acme shape. Variations in other factors for the same nominal size pipe joint are due to the desire to incorporate specific features in each design. For instance, one drilling operator may have adopted a casing program that requires the use of the smallest O.D. tool joint possible on 3½-in. nominal size drill pipe; he sacrifices strength to obtain this 4 in. diameter. Or a particular fishing job may permit only the use of this size pipe and joint. Another operator believes that mud volume is more important; his casing permits larger drill pipe with larger tool joints and correspondingly larger inside diameters. Or to another, strength may be the dominant factor: Deep drill may require the use of a tapered string.

For whatever requirements, a tool joint has been designed with features best for that particular usage. As shown by the table, for 2⅞-in. nominal size drill pipe with the most popular tool joints, joint "A" has the smallest outside diameter, API internal flush the largest inside diameter, joint "B" the greatest tensile and torsional strengths. Another tool joint manufacturer, provides a product that is flush with the outside diameter of the drill pipe; strength and inside diameters are reduced accordingly.

For 3½-in. drill pipe, joint "A" has the smallest outside diameter, API internal flush the largest inside diameter. API regular and full hole have the greatest tensile and torsional strengths

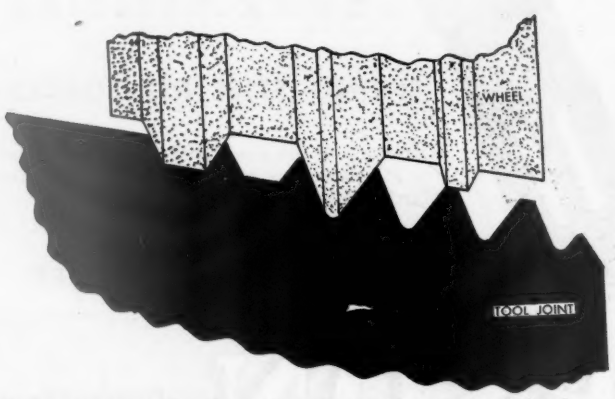


API regular and full hole tool joint thread forms. V-0.040 S0.050 Crest widths

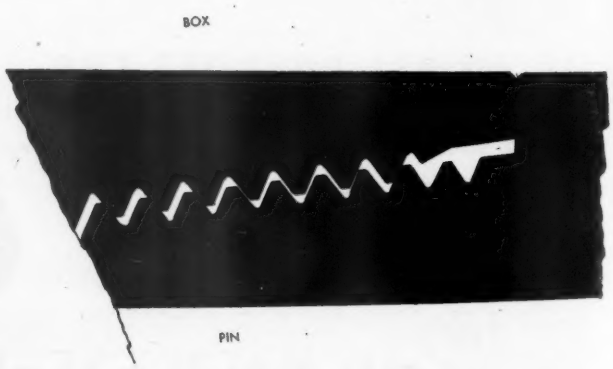
API internal flush tool joint thread forms. V-0.065 Crest.

Acme thread form.

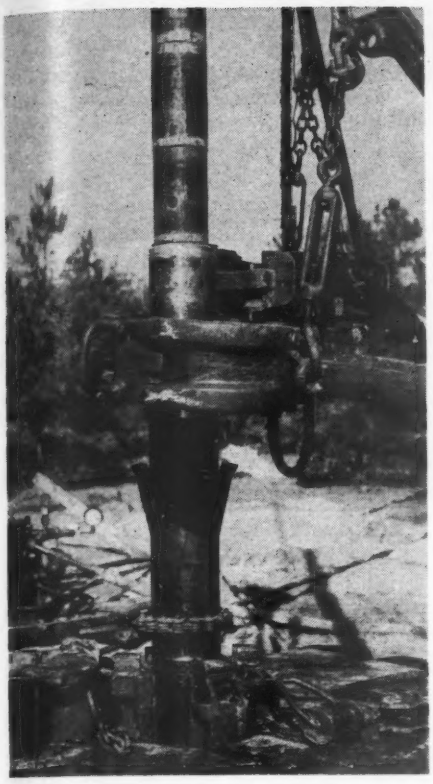
Magnified thread profiles of API Regular and Full Hole, API Internal Flush, and Acme tool joints. The flank angles of the API thread forms are 60 deg to each other and those of the Acme are 29 deg.



In some cases the threads are ground on the joint by a grinding wheel that roughs, forms, and finishes in one pass. The wheel moves in a direction parallel to the thread surface.



This is an example of poor thread contact resulting from lead error. In this case only a few threads carry the load, thus causing excessive wear and possible fatigue failure of these threads.



Often many subs are required to make one connection. Here a tool is subbed by at least three steps to the drill pipe. This is not considered good practice.

respectively. In the 4½-in. drill pipe size, joint "A" still provides the smallest outside diameter, API internal flush the greatest inside diameter and torsional strength; API regular has the greatest tensile strength.

Tool Joint Thread Failures

Intrinsically, all tool joint failures may be attributed to errors in manufacture and/or improper field use. This product has become so standard in years of usage that design can in no way be responsible for failure, likewise, improper metals and heat treatment may rarely be the target for the finger of guilt. The errors of manufacture are unintentional and, if design and metallurgy are satisfactory, lay wholly within the process of threading. Field practises are different and only those that affect the threads of the joint will be brought into focus.

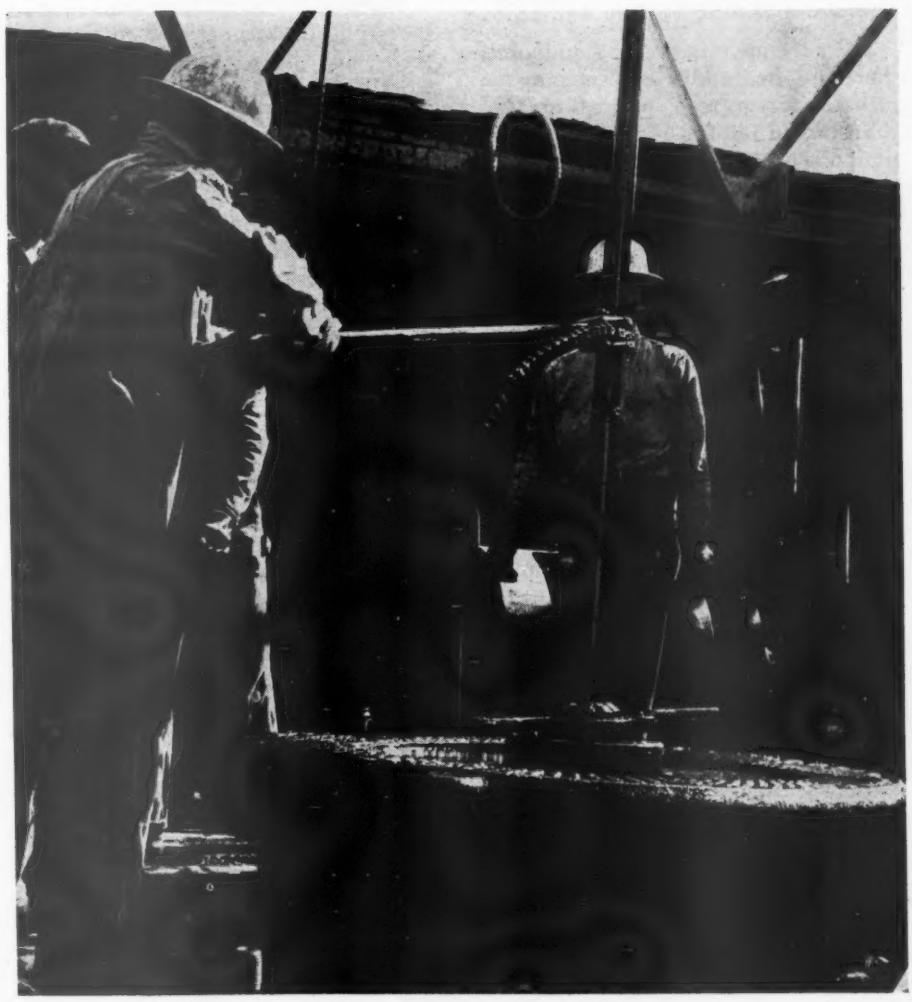
The errors of manufacture in making the thread on the tool joint lay in three factors: Taper, lead, and thread form. Of the first, there are nine possible combinations of misfit threaded connections that may cause galling or fatigue failure. Lead error produces only one serious misfit; this results in interference and galling. The errors in thread form can result in 36 combinations of misfit with the resulting galling, uneven wear, and eventual fatigue failure certain to occur.

The taper on tool joint threads provides a releasable means of wedging the joint tight; however, due to the fact that the threads are designed properly to engage only at the extreme travel of the joint, errors in the taper result in very poor connections. This type of error is magnified in geometrical proportion so that a small error in taper can result in a fairly large variation in other thread elements. For instance, a variation in pitch diameter of 0.001 in. on a 2 in. taper per foot results in an axial movement of 0.006 in. Or 0.001 in. variation in pitch diameter on a ⅜ in. taper per foot, results in an axial travel of 0.032 in., which is considerable in threads held to tolerances of 0.001 in. This means that thread gage standoff predictions may seem true while actually being in error. Of the nine possible misfit combinations resulting from error in taper, only two (where both pin and box members have a plus taper or a minus taper) result in loose fits; the others are shoulder fits resulting in interference contact at either the large or the small end of the mates.

Lead error in threads produces a rapid change in pitch diameter. For instance, if the lead error is held to 0.003 in. in a plus direction, the change in pitch diameter of a gage before fitting this thread would be 0.0052 in. Assuming a 2 in. taper per foot, the axial travel resulting from this lead error would be 0.0311 in. This figure would be increased by two if the lead error of the connecting members were in opposing directions.

Errors in thread form result from improper flank angles, variations in thread truncation, and root clearance. Three possible flank angles cause six combinations of fits per member and upon engagement with mating members may result in 36 different combinations. In cases where the threads are too thin, resulting in reduced crests and widened roots, the crest corners of one member may interferingly contact the root radius of the mating member. This leaves the load carrying flanks open, and stress concentrations

New tool joints should be made up by hand until broken in to prevent the possible galling action of fast make up by the spinning line.



result that cause uneven wear and fatigue failure.

In a word, just how important are the errors of taper, lead, and thread form in the occurrence of the failures of thread galling and fatigue? They are factors that are as large in these failures as the magnitude of the error committed. How can they be prevented if the gages themselves, by which the perfection or imperfection of the thread is determined, are misleading? One experienced engineer, engaged for many years in the inspection of threaded members, stated, that due to the geometric features of the tapered design, even perfect gages will not guarantee the accuracy of the thread on the product; no solution can be found other than more closely observed tolerances in taper, lead, and thread form, thus holding these variables to a minimum.

While tool joints are not made for molly-coddling, even their rugged characteristics can be of no avail in preventing thread failures in the face of severe mishandling in the field. Unclean joints, poor thread lubricants, good and bad thread engagement, fast make-up in breaking in, "spring hooking" upon break out—all damage the thread by which the tool joint hangs.

Tool Joint Thread Failure Remedies

From the manufacturing standpoint, there are two additives that may be utilized to prevent premature tool joint thread failure. In the first place, design is proper; alloy steels with high tensile, fatigue, and impact resisting properties are used. Stress relieved and heat treated to the optimum hardness, the present day tool joints have a compromising physical quality that permits maximum wear with satisfactory strength and ductility. A modified SAE 4140 or 3140 steel heat-treated to 285-321 Brinell units fulfills these requirements; hardfacing bands are applied for greater wear resistance. As for manufacturing errors, plug and ring working gages, carefully and periodically compared with master gages, and a means of determining thread profile may be employed to reduce errors in taper, lead, and form to a minimum. The two addition processes to improve tool joint service life are thread coating and thread root rolling.

It has been known for many years that the galling of threads and mating shoulders can be minimized by the application of a softer material to the thread surface. Accordingly, manufacturers may copper plate tool joint threads for this effect. Another process in recent use is that of the chemical deposition of an iron phosphate coating to the mating threads; still a more recent innovation is that of putting a graphite skin, which-lubricates, on the threads. These coatings, where no other detrimentals are involved, practically guarantee a joint free from galling.

Explore Ethiopia for Oil

Sinclair Petroleum Corporation is searching the desert country of southeastern Ethiopia for oil. One well has been drilling since last May by an American crew assisted by Somali tribesmen. The well is situated in the Gumbora hills section of the Ogaden desert. Sinclair has confined exploration thus far to the Ogaden area, as surface and sub-surface formations there indicate the possibility of oil.

Work was temporarily suspended in 1948 when Somali tribesmen in several disorders caused heavy damage to Sinclair's almost $2,000,000 worth of equipment. Ethiopian troops took over the caretaker job, however, and work has been resumed with no disorders having occurred since.

Perhaps the most successful manufacturing trick employed to prevent tool joint thread failures is a cold working process known as thread rolling. As applied, the threads are made by the usual milling process and rolled only on the finished root. In this process, an old one for applying threads to pliable steel, a small wheel whose periphery has the contour of the thread root, is pressed hydraulically against the product as it is rotated. The radius of the root is thus rounded and its notched fatigue resistance greatly improved.

In fatigue testing, the ability of a steel member to resist the reversals of stress is reduced by a factor greater than 50 per cent if a groove is turned in the surface of the member under test. A thread is such a groove and this accounts for the inherent weakness of the threaded joint. Rounding out the root of this notch, or thread, improves its fatigue limits almost to that of the non-grooved surface bar. In proving this, one of the large tube mills conducted a test on 13 drill pipe joints, 5 in. OD by 4½ in. ID, to determine the effect of thread rolling upon the fatigue resistance of the threaded section. In this particular case, the drill pipe threads, not the tool joint threads, were under test.

The data developed during the laboratory test disclosed that (1) the standard cut thread failed under 10,000,000 reversals of stress and 8000 psi applied load; (2) the standard cut thread with long run-out failed under the same number of reversals with 11,000 psi load; (3) *the standard cut thread that had the root radius rolled failed under the same number of reversals with an applied load of 19,000 psi.* Thus this test indicated that the fatigue strength of threaded drill pipe joints may be increased 240 per cent by cold working the root radius of the thread.

One of the larger tool joint manufacturers substantiated this experiment and found that thread rolling the root radius of the tool joint thread almost restores the original fatigue resistance of the smooth surface before threading.

In the department of care and handling, tool joint thread failures may be reduced by various accepted good practices. Under severe service, frequent inspection by field personnel may result in culling the possible failure joints from the string before the defect has resulted in a parted failure. Such inspection may be made by the magnetic particle method, wherein finely ground iron powder sprinkled over a magnetized joint, outlines the contours of a crack if present. Or a new process, utilizing the fluorescent properties of a special oil, may be used in the same manner. Cracks at the base or root of threads may be easily distinguished.

Aside from inspection, one tool joint manufacturer recommends this care:

(A) Make up the tool joint tightly when going in the hole; as to how tight, a good rule of thumb is to use one wrap of the line around the cathead for each inch of nominal size drill pipe used.

(B) Avoid damage to pin and box shoulders in transit; also when stabbing or jumping the pin out of the box with the spring hook use especial care to avoid damage.

(C) Make up new tool joints by hand; high speed make-up of new connections may result in galled threads.

(D) Make sure kelly sub threads and shoulder are in good shape.

(E) Don't force improperly mated threads to shoulder.

(F) Use a good quality thread lubricant; 50 per cent zinc base preferred. Use a special lubricant for strings that are fishing.

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API Specifications, Std. 7-B, August, 1947.

* * *

Baash-Ross News

BAASH-ROSS TOOL COMPANY • LOS ANGELES • HOUSTON • OKLAHOMA CITY • NEW YORK

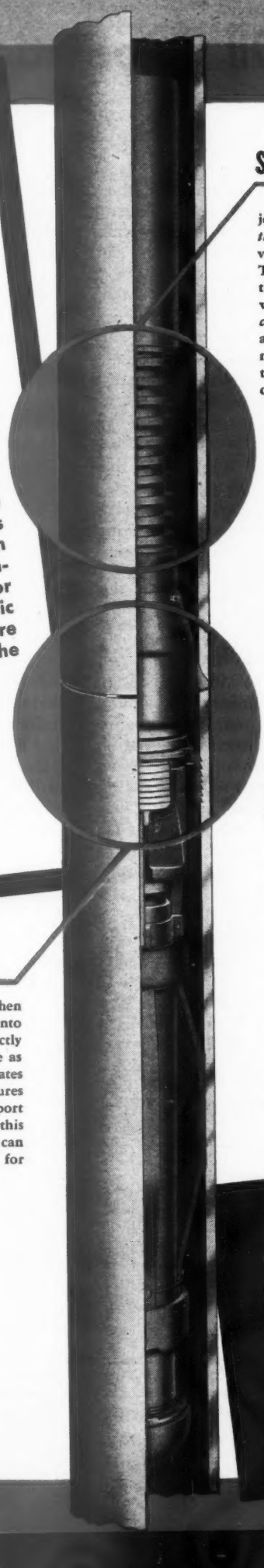
OUR 30th YEAR

3 Unique Features

mean Smoother Cuts, Faster Cuts, More Cuts with

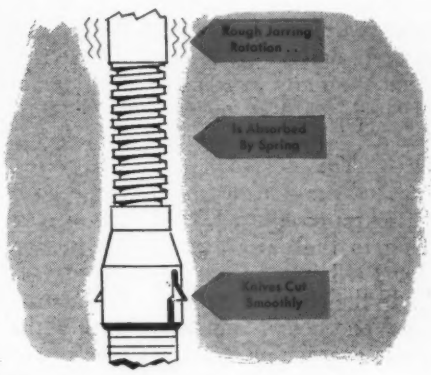
BAASH-ROSS INTERNAL CUTTERS!

When you have an internal cutting job, it's not enough simply to order an "internal cutter." All pipe cutters work on the same general principle—that of expanding knives against the surface of the pipe to be cut, then rotating these knives until the cut is completed. But the important things to look for are the engineering refinements in this basic principle—the *extra* advantages that insure maximum cutting efficiency under even the most adverse operating conditions. And that is why the Baash-Ross Internal Cutter has been the outstanding choice among leading operators for over 20 years—because it embodies three vital advantages that make a very substantial difference in the over-all operation and dependability of the tool . . .



SMOOTH SPRING-CUSHIONED FEED!

Note the spring between the knives and tool joint connection. All weight is applied to the knives *through* this coil spring which cushions out the jarring vibration and irregular feed of the rotating drill string. This Baash-Ross feature is a great advancement over the conventional arrangement of applying the bare weight to the knives, for it provides a *spring-cushioned* feed that protects the knives against breakage, insures smoother cutting action, and eliminates need for any complicated accessory equipment to control weight. Even under the roughest and most adverse conditions, you get a clean, smooth cutting action!



WIDE CUTTING RANGE WITHOUT CHANGES!

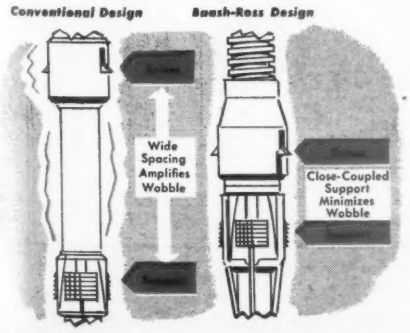
To the above features add this additional advantage—the Baash-Ross Internal Cutter not only permits *repeated* cuts to be made at different locations without removing the tool for resetting, *but the same tool will cut all weights of a nominal size API casing, tubing or drill pipe without any changes whatever in knives, slips or other parts.*

This means that multiple cuts can be made—not only in standard strings, but also in *combination* strings—all on ONE trip into the hole.

If you are not sure where the pipe is stuck, simply start at either the bottom or top and make successive cuts up or down the string, as desired, until the fish is free. No need for separate trips to adjust for different weights of pipe in the string or to make any changes in the tool. You get faster, more economical cutting jobs, greater adaptability, simpler operations!

CLOSE-COUPLED NON-WOBBLE SUPPORT!

Have you ever noticed how a lathe tool cuts smoother when working *close* to the support? This same principle is engineered into the Baash-Ross Cutter, for the support slips are positioned directly below the knives so that the cutting point and support point are as close together as possible. This unique feature virtually eliminates all wobble, chatter, and off-center strains on the knives, and assures a much smoother, faster cut than is possible when knives and support slips are widely separated as in conventional design. Combine this feature with the *spring-cushioned* feed outlined above and you can readily see why the Baash-Ross Internal Cutter is unmatched for smoothness, for safety, for all-around cutting dependability!



A TYPE FOR EVERY CUTTING JOB—TUBING, DRILL PIPE, CASING!

No matter what the size of pipe to be cut, no matter what its thickness or coupling design—even Internal Upset pipe—there is a size and type of Baash-Ross Internal Cutter to handle it. There is a Baash-Ross representative conveniently near you who will be glad to give full details . . . or write direct.

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Government of Venezuela Reports on Oil Operations

THE Ministry of Public Works has made public some of the results of the petroleum activities in Venezuela, during the year of 1949.

1. Production.

During the year 1949, the daily average of petroleum production was 210,082 cu meters (1,321,367 bbl). If we compare that daily average with the average corresponding to the petroleum production obtained during the year 1948, which was 212,852 cu meters daily (1,338,794 bbl), we find that the daily average production for 1949 is 2770 cu meters (17,423 bbl) smaller than the average obtained in 1948. This decrease in the daily average of the petroleum production for 1949 represents a 1.3 per cent in relation to the daily average production for 1948.

In the chart "Petroleum Production in Venezuela", appears monthly the daily average production of each company operating in the country. In this chart, the variations of the daily average of petroleum production in Venezuela during 1949 may be observed. In fact, it decreased to a minimum of 1,155,476 bbl per day during the month of March, and then it started continuously increasing until it reached a maximum of 1,440,323 bbl per day during the month of December.

2. Refining.

From January to November of 1949, the quantity of 7,607,788 cu meters (47,851,313 bbl) of mineral oil were refined in the nation. If we assume that the quantity of mineral oil refined during the month of December was equal to that of November, it can be affirmed that during the year of 1949, a quantity of 8,424,848 cu meters (52,990,440 bbl) of mineral oil was refined in the nation. Such figures represent an increase of 1,507,075 cu meters (9,479,170 bbl) above the quantity of mineral oil refined in 1948, which was 6,917,773 cu meters (43,511,270 bbl). This represents an increase of 21.8 per cent.

Comparing the quantity of mineral oil refined in 1949 with 5,851,287 cu meters (36,803,308 bbl) of mineral oil corresponding to the 1947 production, an increase of 2,573,561 cu meters (16,187,133 bbl) can be noticed. This represents an increase equal to 44 per cent.

The quantity of mineral oil refined in the nation in 1949 represents a 10.99 per cent of the production of mineral oil obtained during the same year. The quantity of mineral oil refined in the nation during 1948 represents 8.88 per cent of the petroleum production for that year. Mineral oil refined in 1947 represents 8.46 per cent of the 1947 petroleum production.

The increase that took place in 1949, in relation to refining in preceding years, is mainly due to the fact that the "Refineria Cardon", which belongs to the Shell companies, initiated its refining activities (in Paraguana) in 1949. It is expected that with the "Refineria de Amuay" of the Creole Petroleum Corporation, which will have a capacity of 60,000 bbl of mineral oil per day, the refinement of mineral oil in Venezuela will increase even more in 1950.

3. Exportation.

From the month of January to November of 1949, mineral oil exports reached a total of 61,189,111 cu meters (384,866,047 bbl). Estimating the mineral oil exports in December as 6,100,000 cu meters, we get the quantity of 67,289,111 cu meters (423,233,705 bbl) as the volume of 1949 exports. This quantity is 2,297,480 cu meters (14,450,644 bbl) smaller than the quantity corresponding to the mineral oil exports in 1948, which was 69,586,591 cu meters (437,684,348 bbl). This means that mineral oil exports in 1949 decreased 3.3 per cent in relation to 1948. Comparing the 1949 exportation figures with those of 1947, however, an increase of 4,235,141 cu meters (26,638,105 bbl) is shown. This represents an increase of 6.7 per cent.

On the other hand, during the same months, from January to November, a quantity of 5,213,598 cu meters (32,792,384 bbl) of refined products was exported. Estimating December exports of such products as equal to those of October, we obtain a total of 5,881,750 cu meters (36,994,914 bbl), which represents exports of refined products in 1949. This quantity is 891,134 cu meters (5,605,037 bbl) larger than the quantity in 1948, which represents an increase of 17.9 per cent.

4. New Fields.

In 1949 the following fields initiated their activities as petroleum producers: San Roque, in the Infante District of the Guarico State; Taman, Ribas District, Guarico State; Inca, Aragua District, Anzoategui State; Macoa, Perija District, Zulia State; Ruiz, Infante District, Guarico State; Freites, Freites District, Anzoategui State, and Punzon, Infante District, Guarico State. ***

Production of petroleum in Venezuela during the year of 1949.

Average daily production in barrels.

Companies	January	February	March	April	May	June	July	August	September	October	November	December	Average for the year
Creole	577,948	592,438	530,128	555,443	642,878	643,700	630,810	635,156	663,264	684,064	670,497	665,762	624,505
Shell	389,204	391,415	375,836	379,430	377,735	375,680	409,430	449,920	452,020	426,449	443,083	448,129	409,983
M. G. O.	177,001	149,171	145,545	159,743	164,750	163,819	144,709	168,413	180,072	192,211	193,913	189,672	169,191
Socony	32,077	33,029	33,946	34,512	35,234	35,194	36,875	37,791	38,279	36,799	39,043	38,459	35,951
Texas	21,095	16,257	24,174	22,102	21,398	21,506	24,646	20,272	24,928	27,603	27,091	28,601	23,357
Mercedes	15,169	14,501	15,025	15,345	15,574	15,145	15,259	15,398	15,969	15,774	16,803	16,931	15,581
Sinclair	17,672	17,485	16,759	15,962	15,580	15,408	14,633	14,216	13,734	13,552	13,913	13,533	15,190
Atlantic	10,154	8,791	9,220	9,024	10,009	10,409	11,946	12,146	12,920	13,622	14,492	17,286	11,692
Pantepec	.....	.....	.....	.....	.....	3,301	12,470	12,154	11,772	11,811	11,364	11,852	6,274
Phillips	1,852	1,836	1,913	4,138	3,717	4,641	4,413	6,586	7,293	6,621	7,389	7,668	4,852
Richmond	1,777	2,536	1,786	3,247	3,921	6,104	11,469	4,860	5,061	1,272	240	1,174	3,629
British	1,091	1,077	1,083	1,008	1,006	1,007	1,027	1,020	1,006	1,095	1,206	1,134	1,063
Guasare	.....	144	61	159	132	94	.....	98	118	138	130	122	99
Total	1,245,040	1,228,680	1,155,476	1,200,113	1,291,934	1,296,008	1,317,687	1,378,030	1,426,436	1,431,011	1,439,164	1,440,323	1,321,367

* From Minister of Fuel, Technical Bureau of Hydrocarbons.

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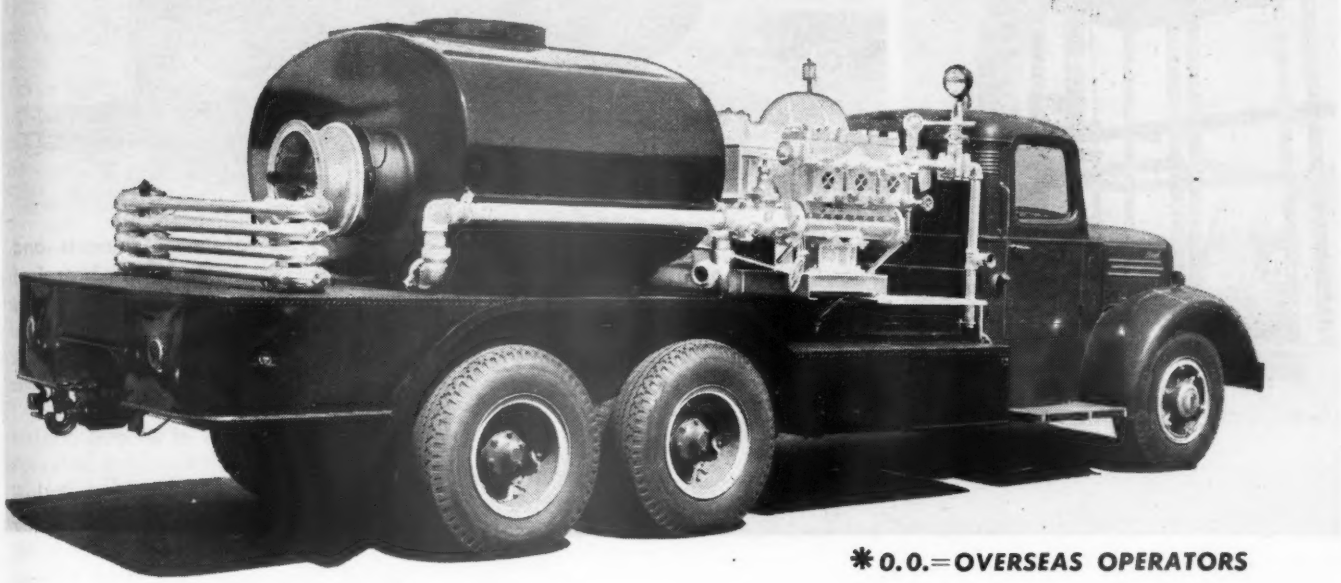
ICI General Service Pumping Unit handles acid, chemicals, hot and cold oils, and drilling fluids easily and economically

Overseas operators now can speed up and simplify a wide variety of pumping jobs with ICI's General Service Pumping Unit. Originally built for service work in the U.S., this tried and proven unit is now offered for export sale. Write today for prices on this versatile time and money saver.



*O.O.=OVERSEAS OPERATORS

NOTE THESE FEATURES

PUMP: Triplex plunger type pump. Design provides for easy removal of plungers. Bleeder line is attached for releasing discharge pressures. Throttle, clutch, and pressure gauge, located on deck of truck, provide for convenient operation from this point.

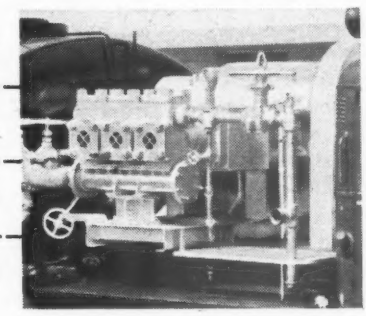
Suction manifolding is flexible. In addition to the line going to the tank, there are two other suction lines. These suction lines can be attached to the pump from barrels, tanks, etc., without disconnecting from the well. Discharge line is equipped with special type valve designed for easy opening and closing under pressure.

TANK: Capacity 1000 gallon or 1500 gallon as d .red. The specially designed, rapidly opened and closed manhole provides convenient access to inside of tank or for the easy entry of additive materials to the tank.

POWER UNIT: Choice of truck is optional. May be gas or diesel as required. Pump operates on power take-off from truck engine.

OTHER FEATURES: Provisions are made for storage of all auxiliary fittings. Large tool boxes are built in chassis. Auxiliary steel discharge hoses, equipped with swing joints, are carried in accessible position on back platform. An operating light illuminates the rear deck. 1500 to 2500 gallon trailers are available for use with these units.

Size	4½" x 8"
Max. rpm	125
Max. Pressure	7500 lbs
Max. Discharge rate	200 gpm



INTERNATIONAL CEMENTERS, INC.

6505 Paramount Boulevard, Long Beach 5, California

ICI Oilfield Equipment

International Cementers, Inc., 420 Lexington Avenue, New York, New York, U. S. A.
"T. I. P. S. A." Avenida Rogue Saenz Pena 501, Buenos Aires, Argentina, S. A.

FIG. 1. Oil heating unit is elevated so that steam, when condensed, will flow back automatically by gravity to the boiler to replenish the feed.

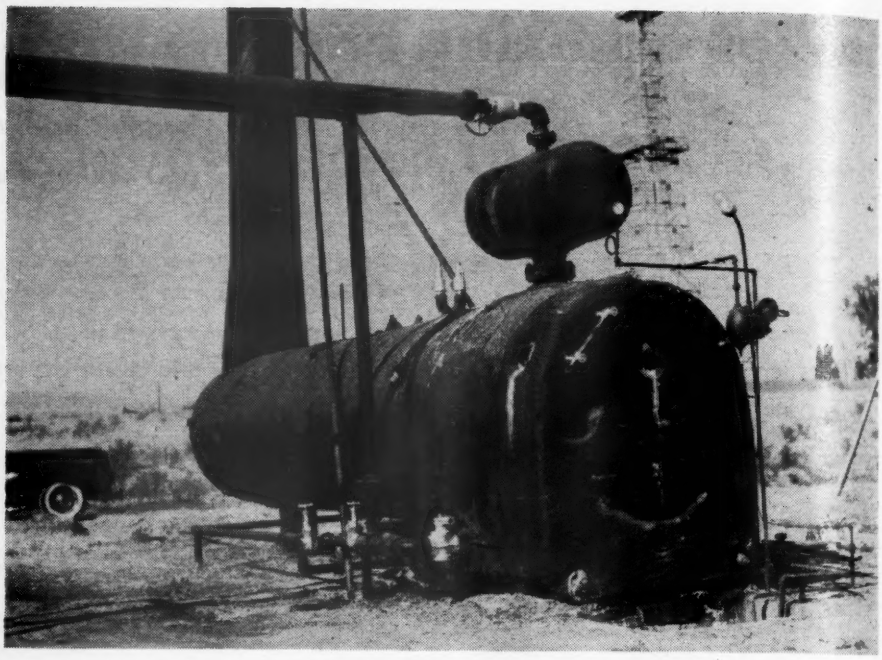


FIG. 2. Conventional oil field boiler equipped with safety instruments and piped so that steam condensate from oil heater, elevated above the barrel of the boiler, will automatically flow back to replenish the feed without pumping.

Automatic Controls on Oil-Treating Boiler

J. C. ALBRIGHT

THE cost of treating cut oil might be reduced materially by equipping a boiler with instruments and piping that return steam condensate for feed water by gravity. When the heat exchangers are placed on a structure with sufficient height above the boiler, the steam condensate will be returned directly to the boiler without pumping.

The principal features of the oil heating unit described here is the placing of the exchangers and the method of piping up the unit. A substantial steel structure is erected near the tank battery to support the shell and tube exchangers at a height sufficient to supply an adequate head on the condensate, so that it will flow back readily to the boiler to be reconverted into steam. This structure is built with a framework surrounding the exchangers and extending above these units so that a sheathing of corrugated galvanized iron can be attached to protect the equipment against inclement weather, and also to prevent the escape of heat to the atmosphere. A door in one end of the building over the exchangers (see Fig. 1) enables the operator to inspect the exchangers and make any adjustment required.

The oil flows directly from the producing wells through the lead line header into the exchangers, and then flows on to the gunbarrel or settling tank where the water breaks out of the cut oil. The piping through the exchangers is fitted with a manifold so that the oil can be switched directly to the settling tanks or gunbarrel when cleaning or repairs are necessary on the heating units.

The oil field boiler (Fig. 2) is fired with natural gas through a volume controller that regulates the volume of gas used to maintain the necessary production of steam for treating the cut oil. The equipment on the boiler also includes a float chamber attached to the front at the position of the customary manually-operated water level indicating gages. This float works in conjunction with a switch* that, in turn, energizes an emergency control valve in the gas line that shuts off instantly should the water level fall in the boiler below the safey level.

This equipment is maintained in first class condition, the flues being rolled tightly in the sheets and all fittings and connections made up with proper gaskets and seals to prevent the escape of steam and steam condensate. Because of this, it is not necessary to add much make-up water to the boiler. The steam generating section and the heat transfer units operate around the clock with only casual inspection each time the lease operators visit the tank battery. * * *

*Mercoid.

EXCLUSIVE

EXCLUSIVE

An Automatic Flow Line Safety Device

C. A. KIZER*

In recent years, the increasing demand for natural gas and the ever deeper drilling in search of more petroleum has resulted inevitably in generally higher operating pressures on surface installations and flow lines. These higher operating pressures have caused various operating difficulties, particularly "freeze-ups," which block flow and cause flow lines to burst. Such accidents often do considerable damage. Several methods have been devised to protect flow lines that are under considerable pressure. One method involves the use of a full opening gate valve that closes automatically when pressures on the flow line rise or fall to a dangerous point.

The flow line safety device described herein is simply a pressure-operated gate valve employing one or two pilot valves, or pilots, to close the valve automatically whenever the operating pressure on the flow line rises or falls to the predetermined setting of these pilots. Referring to Fig. 1, it is seen that this device employs a piston on a hollow stem that is threaded into the conventional full opening gate. This piston works inside a cylinder that is installed on the valve in place of the usual bonnet, wheel, and opening stem.

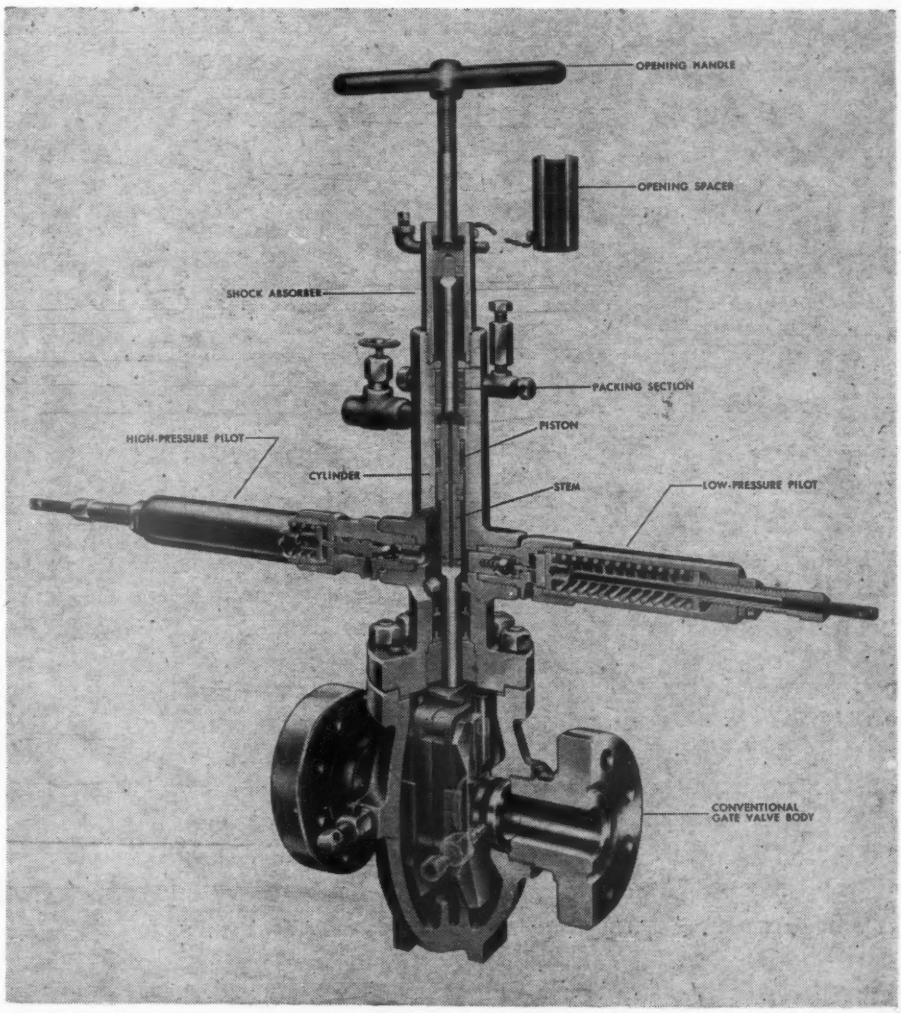
The principle of operation is as follows: In the open, or normal flowing position, line pressure is applied equally through the hollow stem to both sides of the piston. So long as this equalized condition across the piston exists, the valve remains open, because the upper end of the packed-off stem is exposed only to atmospheric pressure, whereas the lower end is subject to normal line pressure. When the pressure beneath this piston is exhausted to atmosphere, however, the full line pressure is then applied only against the top of the piston and instantly closes the valve. This pressure beneath the piston is exhausted from the cylinder by means of the adjustable spring-loaded pilot valves screwed into the cylinder beneath the piston. The pilot valves snap open automatically when line pressure rises or falls to the high or low limit for which they are set. This gate valve may be equipped with either one or both pilots.

After this valve has been closed on the flow line, the full shut-in well pressure may develop eventually in the cylinder above the piston. Such pressure would only hold the valve closed more tightly. The valve is designed to remain closed until opened manually and returned to service. In instances where the setting of either pilot is as much as 2500 psi or higher, a shock absorber is used to slow down the closing velocity of the gate.

This automatic valve employs the same body, gate, and sealing mechanism as developed for use on Christmas trees. This provides a full-opening conduit in the flow line where the device is installed. A full range of valve sizes in various test pressures are available.

Outside connections under pressure are not required to operate the valve. There are some special applications, however, where one outside line is connected, but the standard models need no small, exposed outside lines, in which fluids are apt to freeze and prevent operation of the safety device when it is most needed.

FIG. 1. Surface safety valve.



*Petroleum Engineer, Otis Pressure Control, Inc., Dallas.

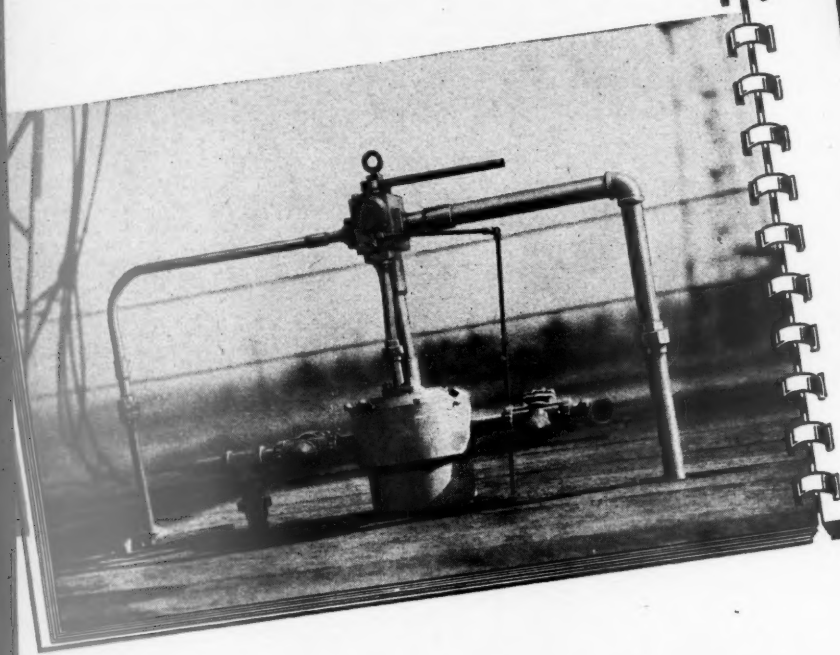
Free Pumping
LOWERS OPERATING COSTS 66%
...and that's only half the story*

CASE HISTORY

Well No. 26

DEPTH 4710'

DOMINGUEZ FIELD, CALIFORNIA



CASE HISTORY

Comparative 4-Year Operating Costs of Two Wells on Same Lease

The detailed operating costs kept on two Dominguez wells over a period of four years (see below), dramatically reflect the savings achieved by Free Pumping. As the chart and figures show, the big difference in operating cost of the two wells is in pump pulling. Total 4-year pulling cost for the rod pump well was $871; for the Free Pump well only $37.

BREAKDOWN OF OPERATING COSTS

	Well No. 26 Free Pump (51 months)	Well No. 52 Rod Pump (50 months)	Well No. 52 Free Pump (7 months)
Depth	4710 ft.	4228 ft.	4228 ft.
Pump Repair Cost (cost/bbl.)	.58c	.53c	.00c
Pump Pulling Cost (cost/bbl.)	.05c	1.30c	.00c
Total Cost (cost/bbl.)	.63c	1.83c	.00c

***The second half of the story** is even more surprising. It starts with the conversion of Well 52, with which Well 26 is compared, to Free Pumping. In seven months since the conversion was made, no expense has been incurred for repairs or pump pulling.

The performance of *Free Pumping* recorded here is not an isolated instance. *Free Pumping* consistently reduces operating costs because it eliminates the high cost of pump pulling and downtime losses. There is no waiting for equipment. No long delays due to weather or road conditions. One man alone can change a bottom hole *Free Pump*.

Paraffin control—another big expense in some fields—is reduced to a routine operation with *Free Pumping*.

To cut your operating costs, plan now to convert to *Free Pumping*. Call your nearest Kobe representative.

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In order for the pilot valves to operate effectively at the desired settings, the control elements were designed without the use of packing. The pilot valves may be adjusted easily in the field to meet changing well conditions by simply shifting the position of the lock nut on the adjusting screw.

Plastic packing is used to seal off around the stem at the top of the valve. It is possible to repack the valve under pressure.

Typical Applications

Some of the uses for such an automatic safety valve follow. Perhaps the most obvious use for a safety valve on a flow line is to shut in the well when an accident to the flow line occurs that might allow the well to flow wild. For this purpose, a valve is installed just beyond the last choke on the flow line and set to close when the pressure drops to a point known to be below the last normal flowing pressure on the line.

A similar application may be made on wells drilled in the overflow area of a river, where the separators, tanks, or heaters are installed within the flood area. A safety valve may be installed on the flow line to close in the well should damage occur to any of these surface installations.

Another application for an automatic flow line shut-off is on gas wells or very high ratio oil wells flowing at fairly high pressures, where the possibility of hydrates freezing is present. A safety valve may be installed and set to close just before the burst plate on the separator blows, or at a maximum pressure considered safe for the flowline. This application may save considerable loss of well fluids and property damage.

Recent investigations by several companies reveal that other savings may result from the installation of such safety devices. Where large gas gathering systems are being designed, ordinary safety precautions have necessitated buying a weight of pipe capable of withstanding the full shut-in pressure of the wells, so as to prevent accidents should a plug be frozen in the gathering line. In such a system, dependable safety devices installed near the well heads, set to close at a line pressure well below the full shut-in well pressure, would enable the operator to buy lighter pipe. A saving of many tons of steel might thus be effected, paying for the safety devices many times over.

In several fields in the Rocky Mountain area, and one in Western Canada, there are high pressure flowing gas

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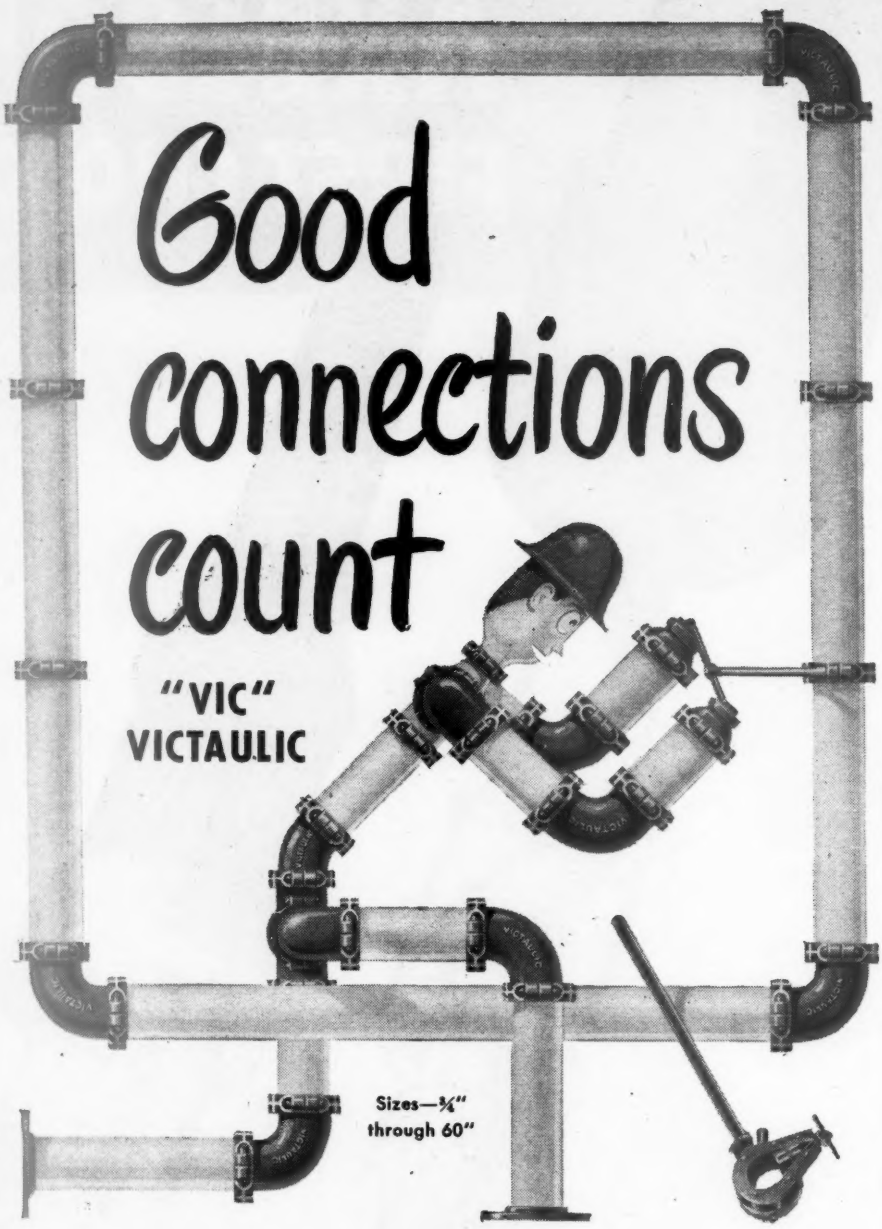

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Victaulic Catalog and Engineering Manual No. 44. "Vic-Groover" Catalog No. VG-47.

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26TH VICTAULIC YEAR

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PIPE COUPLINGS AND FITTINGS

wells with high concentration of H_2S that will freeze up solid even down in the tubing, unless a system is used of circulating hot oil down around the tubing and back to the surface through an intermediate string of casing. In several of these systems, one or more safety devices of the type described is installed on the oil line at the well and employs one high pressure pilot set just greater than the line pressure. If a leak develops in the circulating oil line, the safety valve will automatically shut in the oil line; otherwise gas from the well would enter and raise the pressure in the circulating oil system, releasing gases so poisonous as to prevent operating personnel from closing in the wells.

A recent installation on one of the platforms in the Gulf of Mexico is worthy of note; it shows another instance of the trend toward more protection with automatic safety devices on these extremely costly locations. The safety valve is installed on the Christmas tree between the wing valve and the surface choke where the flowing pressure is more than 500 psi. A special pilot on the valve is connected with ½-in. line, not under pressure, to two automatic valve-actuating controls, one at the separator and one at the tank battery on the same platform.

When an automatic high level control at the separator is tripped, a few pounds' pressure is transmitted through the ½-in. line to the safety valve, causing the pilot to open and the valve to close. Likewise, if all the tanks on the platform are filled up in series, and there is no other place for the oil to go, a float-type control on the last tank opens, which transmits a small amount of pressure to the safety device, closing the well.

In additon to these two automatic means of shutting in the well with the safety device, this company has rigged up a cable from a valve on the separator. The cable hangs over the side of the platform and has a large loop on the end. When the water in the Gulf is so rough as to prevent mounting the platform in any way, a man with a boat hook should be able to snag the loop, and pull hard on the cable. This causes the safety valve to close in the same manner as though it were tripped automatically.

These are only a few of the many uses found for this automatic safety valve, which has been installed on wells with flowing pressures as high as 8200 psi, and also on wells where the safety device must close at 40 psi, and in sizes from 2-in. to 12-in., in many fields in this country as well as in several foreign fields. * * *

How to Reduce Your Oil Well Pumping Costs by Power-Factor Improvement

J. N. POORE*

How would you like to save some money on your oil well pumping costs? Quite a number of oil companies are doing just that today by taking advantage of improvement in their lease power factor.

You who operate electrically pumped wells can obtain a saving of 5 to 15 per cent on your power bill depending on the type of power-factor clause you have in your contract with the power company. Not all power companies have such a clause in their contracts, but many do and it would certainly pay you to investigate.

It may be a simple matter to cut lease power costs. One way is to improve the power factor on your oil well pumping leases.

To the uninitiated in the art of electricity, the term "power factor" may be a mysterious term that even some electrical people have difficulty explaining.

What is Power Factor?

From elementary electrical principles we know that to calculate the power flowing in a d-c circuit, we measure current and voltage. A wattmeter would then give a reading:

$$\text{Watts} = \text{volts} \times \text{amperes}$$

In an a-c circuit, if we supply resistance load such as lamps, heaters, etc., the above expression still holds true, but should the a-c circuit contain magnetic apparatus such as induction motors, transformers, etc., we find the wattmeter reading is less than the product of volts times amperes. What then is happening to all the amperes? The answer is—a part of the total amperes is going into providing power and the remainder performs the very necessary function of magnetizing the induction motors, transformers, etc., that require it for performance. Thus, part of the total current is performing a function other than delivering power.

The proportion of magnetizing current to total current will vary widely depending on the characteristics of the load. The relationship of the power-producing current to the total current is termed the "power factor."

$$\text{Power factor} = \frac{\text{power amperes}}{\text{total amperes}}$$

Now power current times volts equal watts, but as seen above, total current times volts is not all watts—hence:

$$\text{Power factor} = \frac{\text{power amperes} \times \text{volts}}{\text{total amperes} \times \text{volts}} = \frac{\text{watts}}{\text{total amperes} \times \text{volts}}$$

On your oil well pumping leases you draw more current — total amperes—than you actually get productive power from, hence you have a low power factor, usually of the order of 50 to 70 per cent.

Now, if you reduce that part of the total amperes that are used for magnetizing the induction motor driving your oil well, you can increase your power factor. This can be done simply and easily. You merely install a capacitor in parallel with the motor. The capacitor supplies the magnetizing current for the motor so that only the power current has to be taken from the distribution system. The increase in power factor will depend on how big a capacitor you use and how much you reduce the magnetizing current from the line.

You now ask — what does all this mean so far as reducing my power bill is concerned?

Power Factor vs Power Cost

It is a fact that for a given kilowatt (1000 watts) load, the total kva (1000 volt amperes at unity power factor) will increase as the magnetizing kilovars increase, and hence as the power factor decreases.

It is obvious that as this total kva increases, the current demand from the line increases. Thus, a power plant supplying one load rated 600 kw at 60 per cent power factor would actually be loaded with a total of 1000 kva, while another power plant supplying a 600 kw load at 100 per cent power factor would be carrying only 600 kva. The current in the latter case is only 60 per cent as great as in the former.

It is evident that the cost of equipment and facilities to supply power to the 60 per cent power factor load of 1000 kva is considerably more than that required for the 100 per cent power factor load totalling only 600 kva. It is for this reason, therefore, that many power companies institute rate schedules so that the user whose power factor is high is rewarded by a reduction in his power cost.

These rate schedules will vary among power companies depending on conditions existing in the area each power company serves and the local conditions of power generation, distribution, and consumption.

Other Advantages of High Power Factor

So far, we've talked only about reducing the power bill by improving the power factor. There are, however, quite a few other advantages.

The voltage drop in the distribution system is proportional to the line current and the line impedence. A reduction in either or both of these factors reduces the voltage drop. Line impedence is made up of a resistance component and a reactive component. Improvement in power factor reduces the reactive component of the impedence and, hence, directly affects the amount of voltage drop in the system. An improved power factor means, therefore, less voltage drop and a higher voltage level on the system.

The size of wire used in the distribution system is determined in part by how much total current the wire must carry. Mechanical strength of the wire for a certain pole spacing is

*Petroleum specialist, General Electric Company, Dallas, Texas.

EXCLUSIVE

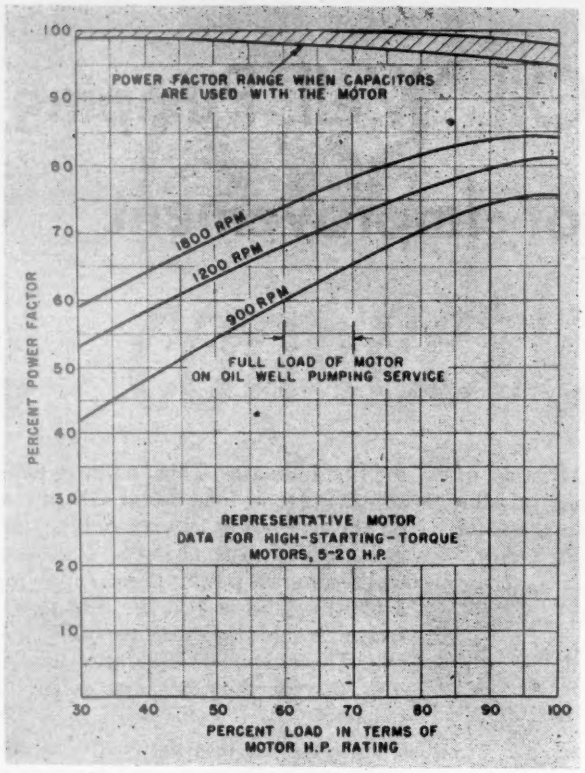


FIG. 1. Variation in motor power factor with load.

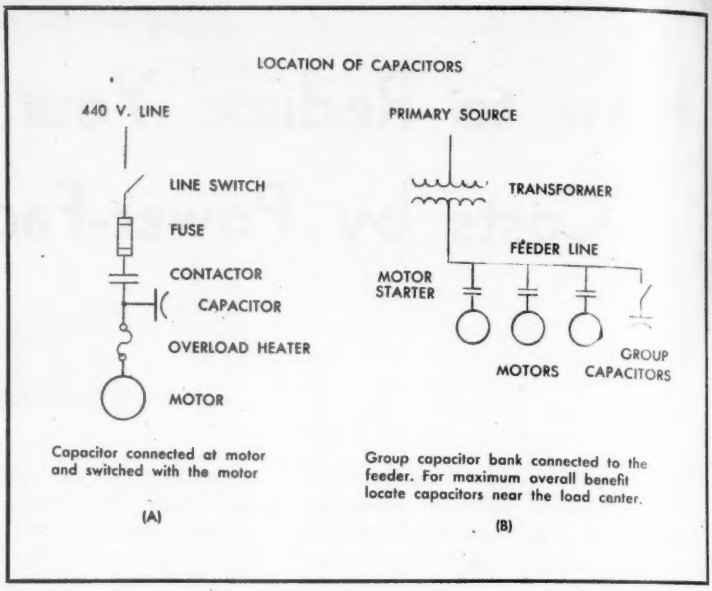


FIG. 2. Two methods of connecting capacitors in system.

also a factor. If this total current is reduced, then a smaller size wire — hence less expensive wire — can be used within the limits of the mechanical strength of the wire, or more total current can be carried in the same size wire, so that more motor load can be served by the same size wire.

The transformer bank size selected to serve a number of wells is likewise affected by the total current drawn from it to serve a group of wells. Transformer banks are rated in kva rather than kw. As we saw before, kva is the product of total current times voltage. By improving the power factor and thus decreasing the total current, we reduce the kva required and hence a smaller transformer bank can be utilized, or we can serve more wells from the same size bank.

Another factor often overlooked in the cost of power for an electrified oil well pumping lease is the matter of losses in the distribution system due to low power factor. Losses in the distribution system are proportional to the square of the total current. As this total current is reduced in direct proportion to the improvement in power factor, the system losses are also proportional to the square of the power factor. For example, if the lease power factor is improved from 65 per cent to 95 per cent, the system losses at the improved power factor are only $(65/95)^2$ or 47 per cent of the losses at 65 per cent power factor. And remember, you are paying for those system losses.

A summary of the advantages gained with improved power factor include:

(1) Reduction in your power bill, if your power contract includes a power factor clause, or its equivalent, and such a clause is enforced.
(2) Reduction of substation capacity.
(3) Reduction in distribution system conductor size or an increase in the number of wells that can be served for a given voltage drop.
(4) Improved voltage level on the system.
(5) Reduction in system losses.
(6) Higher motor starting torque because of improved voltage level on the system.

Cause of Low Power Factor

There is good reason for the existence of low power factor on an oil well pumping motor. Motors for this service are normally selected to have an average load of only 70 per cent of their continuous rated nameplate capacity. The reason for so selecting the motors is to allow for heating in the motor due to the cyclic variation in motor current due to the up and down strokes of the rods and counterweights. Thus, a properly selected motor is really only 70 per cent loaded.

Another factor that affects the motor load is that well conditions will vary from day to day. Some wells will provide a certain amount of lift due to underground gas pressure at the beginning of the pumping period, but this gas boost drops off after a while and all the lift must be provided by the motor. Water encroachment in the well will tend to increase the load on the motor over a period of time. An operator tries to anticipate this and select his motor a little larger than he needs at first, so that his motor won't be overloaded later when water shows up in the well. Some wells paraffin up over a period of time, and, as the amount of paraffin increases, the load on the motor increases. Here again, the operator tries to take this factor into account when he selects his motor size.

When all these factors are accounted for, we frequently find that instead of the motor operating at 70 per cent of its nameplate full load rating, it really is only 40 per cent to 60 per cent loaded.

Now the power factor of an induction motor will vary as the load on the motor varies. Fig. 1 shows how the power factor of the motor goes down as the load on the motor is reduced. Thus, it is easy to see why the power

PENNSYLVANIAN SAND IN VELMA FIELD STEPHENS COUNTY, OKLAHOMA

9

Mud (Aquagel)
R_m = 0.85 ohm at BHT
Bit size: 9"
Spacings: AM = 16"
AM' = 64"
AO = 24'

LOG ANALYSIS

1) Water saturation S

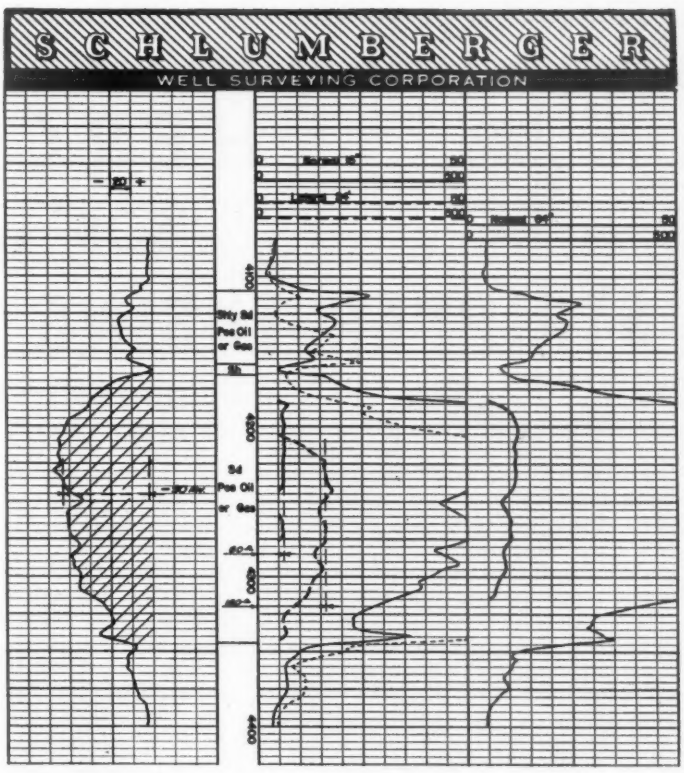
Since R_o is unknown, the method described in "Electric Log Analysis in the Rocky Mountains" by M. P. Tixier, Oil & Gas Journal, June 23, 1949, will be used. Reprints are available from Schlumberger.

The 16" Normal gives 60 ohms. The 24' Lateral gives 160 ohms. With proper correction, from the 16" Normal we obtain R_i = 85 ohms, and from the 24' Lateral, R_t = 102 ohms.

Thus, $\frac{R_i}{R_t} = \frac{85}{102} = 0.83$

SP = –90 mv.

The chart below gives S = 14%



2) Formation water resistivity R_w

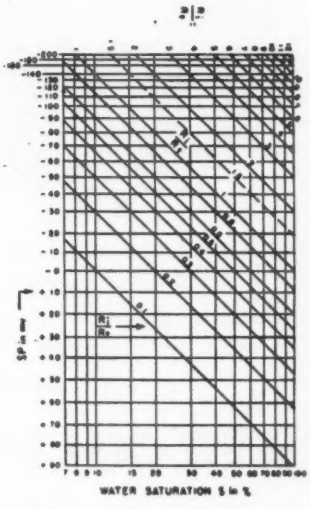
For SP = –90 $\log_{10} \frac{R_m}{R_w}$ = –90 mv.

$R_w = \frac{0.85}{10} = 0.085$ ohmmeter

3) Porosity p

$R_t = \frac{F \times R_w}{S^2}$, thus $F = \frac{102 \times 0.14^2}{0.085} = 23.5$

$p = \sqrt[m]{\frac{1}{F}} = 20\%$ approximately m = 2



Procedure for calculation of per cent of water saturation (S).

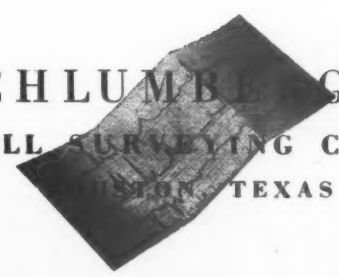
CORE ANALYSIS

Average Porosity	19%
Average Permeability	108 md.
Connate Water by restored state methods	12%

PRODUCTION RESULTS

From North Offset Well (4200-4360)

Swabbed 1228 BO/21 hours
Pumped 151 BO/24 hours 28.5° API
Gas Oil ratio 139/1



SCHLUMBERGER
WELL SURVEYING CORP.
HOUSTON, TEXAS

factor on a pumping lease could easily range between 50 per cent and 70 per cent.

Where to Install Capacitors

Now, if we have a low power factor on the lease and agree that corrective action should be taken, just how and where should the power-factor improvement capacitors be installed and what size should they be?

There are two methods of installing capacitors. First, the capacitor can be installed right at the source of the low power factor—that is, at the motor. A second location is on the feeder distribution lines going to the various motors. Fig. 2, (A) and (B), shows the two methods of application. Fig. 3 shows an individual capacitor mounted just beneath the pumping motor control box and connected into the circuit on the motor side of the control.

As shown in Fig. 2A, the capacitor is connected between the contactor and the overload relay. This is the preferred connection, because no change is then necessary in the overload relay heaters. The current through the overload relay is the motor current, and the heaters can be selected in the usual manner. When capacitors are used, reduction in current stems from the electrical location back through the power system, so with this connection the current through the overload relay is not reduced.

FIG. 3. Capacitor shown connected between motor and starter and mounted on well service pole.

Fig. 4 shows the group capacitor method of application on one of the distribution feeder poles.

There are advantages and disadvantages to both methods of application. With capacitors located at the motor, Fig 2A,

(1) Power-factor improvement is made at the load, resulting in maximum overall benefits.

TABLE 1. Selection table for capacitators when connected at the motor.

(Type KG, high starting torque motors)

Motor rating, hp	Motor sped, rpm 900	1200	1800
	kvar	kvar	kvar
3	2	2	..
5	3	3	2
7½	5	4	3
10	6	5	3
15	10	6	5
20	10	6	6
25	12½	10	6

NOTES:

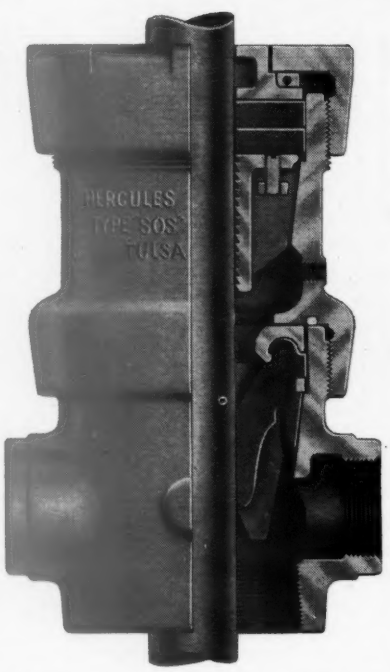
1. The operating power factor with these capacitors will generally range from 95 per cent to 98 per cent at full load and 95 per cent to 100 per cent at partial loads. However, because capacitors are available only in certain unit ratings, it is not always possible to select exact ratings for the motor; therefore, in some cases the power factor at partial load may be less than the full load power factor, although in the range of 25 to 100 per cent load the power factor characteristic is relativley flat.

2. Kvar is the rating of capacitors in kilovolt-amperes connected at the motor terminals.

HERCULES

"SOS" and "SO"

STRIPPER TUBING HEADS



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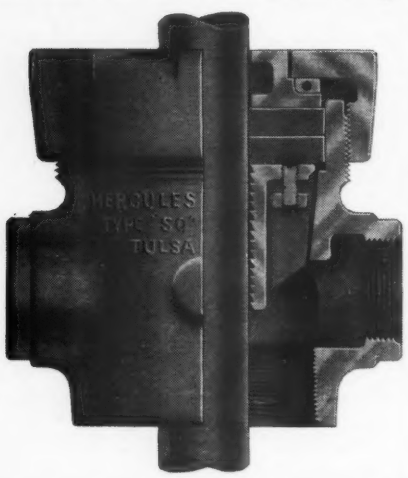

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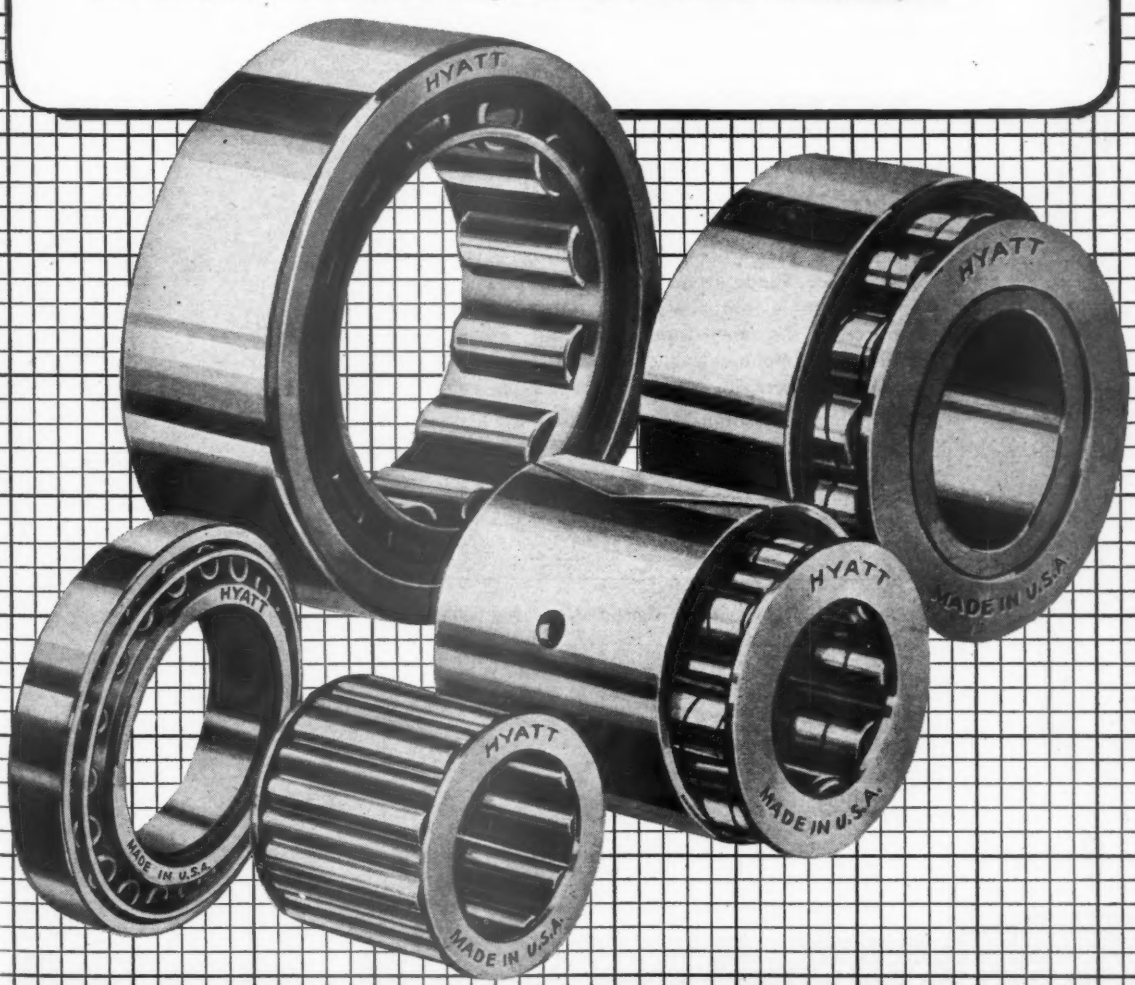

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(2) The capacitor can be switched with the motor, thus providing power-factor improvement automatically and when needed.
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(5) Help is provided in sloping off incoming waves due to lightning or switching surges, thereby protecting the motor windings.
(6) Initial investment in capacitors may be higher than with group capacitor method.

Capacitors connected to the distribution feeders, in Fig. 2B, offers:

(1) Reduction in capacitor kvar due to diversity when all wells are not pumped simultaneously.
(2) Slightly lower cost per capacitor kvar because of larger size capacitors.
(3) Smaller reduction in system power losses because saving in losses is only from the point of capacitor location back to the power source, and there is no reduction from capacitors to motors.
(4) This method may require automatic switching equipment with attendant increase in investment if the load varies considerably or if there are frequent line outages.

Selection of Capacitors

If a capacitor is to be placed at each well, Table 1 may be used to select the size of capacitor for each horsepower size of motor. This table is applicable for high starting torque, normal slip motors, in ratings most extensively used for oil well pumping service. The resulting power factor will be about 95 per cent for the operating load range for well pumping service. When capacitors are connected to the motor terminals, motor underloading has usually very little effect on the operating power factor.

If group capacitors are used, the required capacitor rating may be obtained from Table 2, which includes an example illustrating its use.

Power Rate Schedules

Rate schedules of power companies vary from one company to another, due to conditions peculiar to each company with regard to power generation, distribution, and consumption.

FIG. 4. Power factor improving capacitor, with lightning arresters, connected on 480-volt feeder circuit.

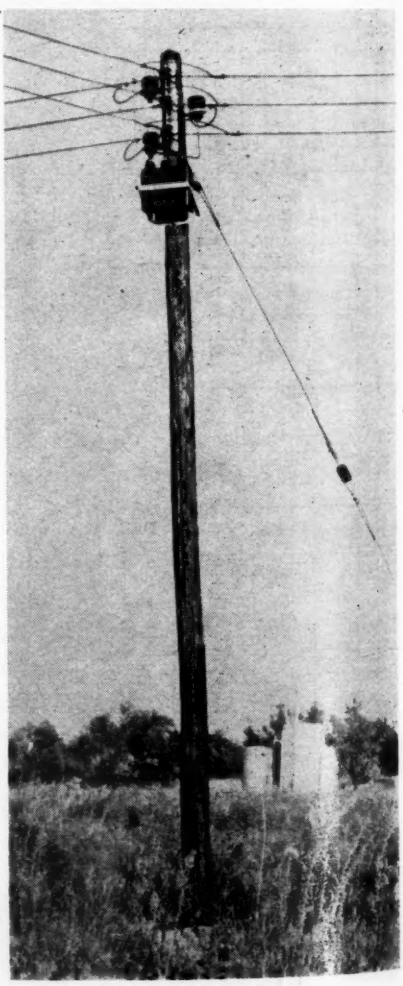

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TABLE 2. Table for calculating capacitors required for various loads when capacitors are connected on feeder lines.

(Figures below multiplied by kw input = kvar of capacitance required to improve from one power factor to another.)

Original power factor in per cent	Desired power factor in per cent								
	85	87	90	91	92	93	94	95	100
50	1.112	1.165	1.248	1.276	1.303	1.337	1.369	1.403	1.732
52	1.024	1.077	1.160	1.188	1.215	1.249	1.281	1.315	1.644
54	0.939	0.992	1.075	1.103	1.130	1.164	1.196	1.230	1.559
56	0.860	0.913	0.996	1.024	1.051	1.085	1.117	1.151	1.480
58	0.785	0.838	0.921	0.949	0.976	1.010	1.042	1.076	1.405
60	0.714	0.767	0.850	0.878	0.905	0.939	0.971	1.005	1.334
62	0.645	0.698	0.781	0.809	0.836	0.870	0.902	0.936	1.265
64	0.580	0.633	0.716	0.744	0.771	0.805	0.837	0.871	1.200
65	0.549	0.602	0.685	0.713	0.740	0.774	0.806	0.840	1.619
66	0.518	0.571	0.654	0.682	0.709	0.743	0.775	0.809	1.138
68	0.459	0.512	0.595	0.623	0.650	0.684	0.716	0.750	1.079
70	0.400	0.453	0.536	0.564	0.591	0.625	0.657	0.691	1.020
73	0.316	0.369	0.452	0.480	0.507	0.541	0.573	0.607	0.936
75	0.262	0.315	0.398	0.426	0.453	0.487	0.519	0.553	0.882

Example:
What kilovars of capacitance (capacitor kvar) are required to improve the power factor from 65 to 95 per cent for a 150-kilowatt load?
From the table, the kilowatt multiplier is 0.84. The kvar required is 150 × 0.84 = 126.
Use 120-kvar bank, the nearest standard.

Most power company rates consist of two types of charges. First is the demand charge, based on the maximum power you require to operate your lease either in kilowatts or kva. Second is the energy charge that constitutes the actual number of kilowatt hours of energy used by your well pumping load. The sum of these two types of charges represents your total power bill.

Both the demand charge and energy charge usually have sliding scales. The more power you use the lower your cost per unit of demand or energy becomes.

One clause included directly or indirectly in many power rate schedules is a power factor clause.

To properly measure energy requirements from generating and distribution equipment, the power factor of the utilization equipment must be taken into consideration as well as direct wattmeter readings.

Some power companies base their demand charge on a kva demand basis instead of kw demand. For a given kw of load, the kva demand will decrease as the power factor increases, thus your kva demand charge goes down as the power factor improves. This is one type of power-factor clause.

Other power companies base their demand charge on a kw demand basis but will adjust the billing demand to take in account actual power factor as compared to a base power factor. For example:

$$\text{Billing demand} = \text{actual kw demand} \times \frac{\text{base power factor}}{\text{actual load power factor}}$$

A value of 80 or 85 is often taken as the base factor.

As a brief example of how these two types of power factor clauses work, let's assume your oil well pumping lease has the following conditions:

Total field demand—100 kw,

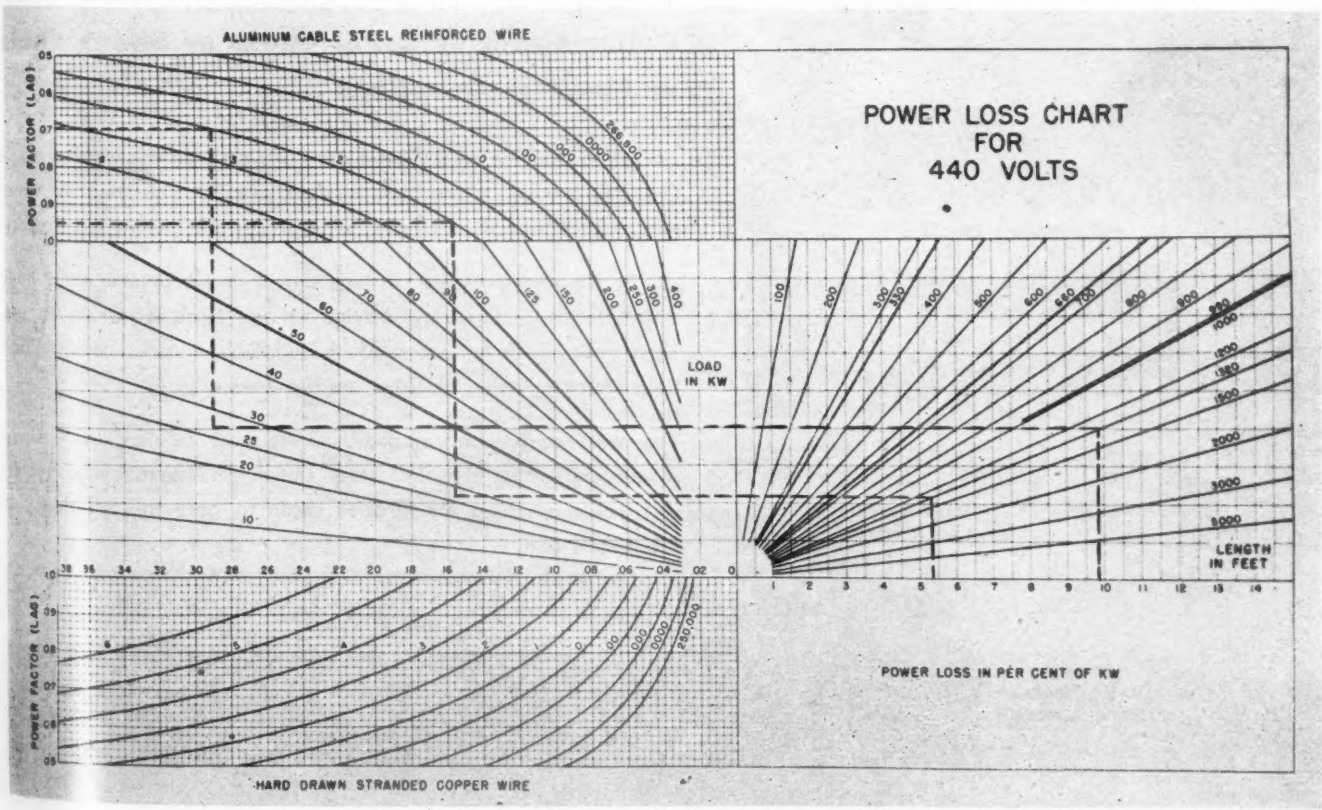
Actual field power factor—60 per cent,

Field power factor when capacitors are used—90 per cent.

In the case of billing being done on a kva demand basis without capacitors you would be charged on the basis of:

$$\text{KVA demand} = \frac{\text{kw demand}}{\text{power factor}} = \frac{100 \text{ kw}}{.60 \text{ p f}} = 166.6 \text{ kva}$$

FIG. 5. Chart giving easy method of finding power loss in distribution system for various loads.



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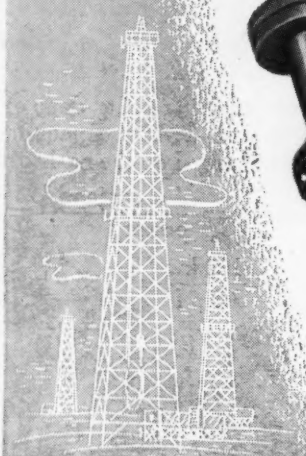

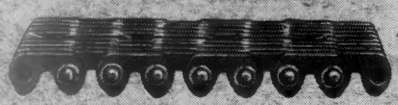

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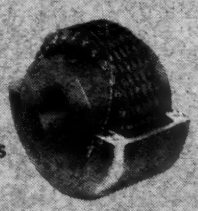

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The Union Chain and Manufacturing Company **Sandusky, Ohio, U.S.A.**

If you improved the power factor to 90 per cent by using capacitors, you would be charged on the basis of:

KVA demand =

$$\frac{100 \text{ kw}}{.90 \text{ p f}} = 111.1 \text{ kva}$$

Here you have saved yourself the cost of 55.5 kva in demand charges each month.

If billing demand is arrived at in the second described manner for the same lease conditions without capacitors:

Billing demand = actual kw demand $\times \frac{80 \text{ p f}}{\text{actual p f}}$

or $= 100 \text{ kw} \times \frac{80}{60} = 133 \text{ kw}$

If you improved the power factor to 90 per cent by using capacitors, you would be charged on the basis of:

Billing demand $= 100 \text{ kw} \times \frac{80 \text{ p f}}{90 \text{ p f}} = 88.8 \text{ kw}$

Here you have saved yourself 44.2 kw in demand charges each month.

As stated before, not all power companies are able to offer such rate schedules, but if your contract does include a power-factor clause, you certainly have an opportunity to save some money.

System Losses

There is another cost saving with improved power factor. If you will recall, it has been mentioned that the losses in your distribution system are directly proportional to the ratio of the square of the power factor.

If you improve your power factor from 60 per cent to 90 per cent, the losses in your distribution system at 90 per cent power factor will only be 45 per cent of what they were at 60 per cent power factor. And remember, you are paying for those system losses.

Fig. 5 is a convenient chart for easily checking the power loss in per cent of the kw load in each section of the secondary distribution system on your lease.

As an example, if a 1320-ft section of No. 2 aluminum distribution line carries 27 kw of load and the power factor is 70 per cent to begin with, and 95 per cent after capacitors have been added, you can determine your system losses as follows: On Fig. 5, follow the dotted line for 70 per cent power factor to where it intersects the No. 2 aluminum wire line, then down to the intersection of the 27 kw load line, over to the intersection of the 1320-ft line and down to the per cent power loss point, where you read a value of 9.9 per cent. This indicates that in this particular section of line for a load of 27 kw at 70 per cent power factor, the loss in the line equals 9.9 per cent $\times$ 27 kw or 2.67 kw.

Repeating the same procedure, except that 95 per cent power factor is now used as a starting point, you will find a power loss of 5.3 per cent. The system loss in this case is 5.3 per cent $\times$ 27 kw or 1.43 kw. By power-factor improvement you have decreased your system loss in one section of line almost 50 per cent. When this reduction is made throughout the entire lease, quite a sizeable saving in kilowatt hours of energy is made with a consequent reduction in your power bill.

The saving in system losses coupled with the reduction in demand charges offers you an opportunity to reduce your operating costs. In addition, you'll gain much better voltage conditions on your system plus increased capacity for adding further wells to the system.

When taking a closer look at operating costs, improvement of your lease power factor certainly offers a good return on a small investment. * * *

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when your sucker rods are equipped with

HUBER SCRAPERS

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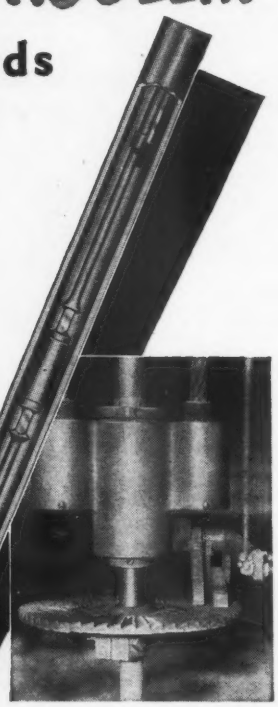
Huber Scrapers quickly pay for themselves. Wells requiring paraffin removal every week or ten days have been on production for months without paraffin trouble after Huber Scrapers were installed.

If paraffin's a problem, install Huber Scrapers. Write for descriptive bulletin.



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This rod hanger rotates the rod string a fraction of a turn on each reciprocation. The horizontal teeth on the turn table are engaged by two ratchet levers which are actuated by a flexible steel cable attached to the walking beam. On each reciprocation the levers move the rod string a fraction of a turn.

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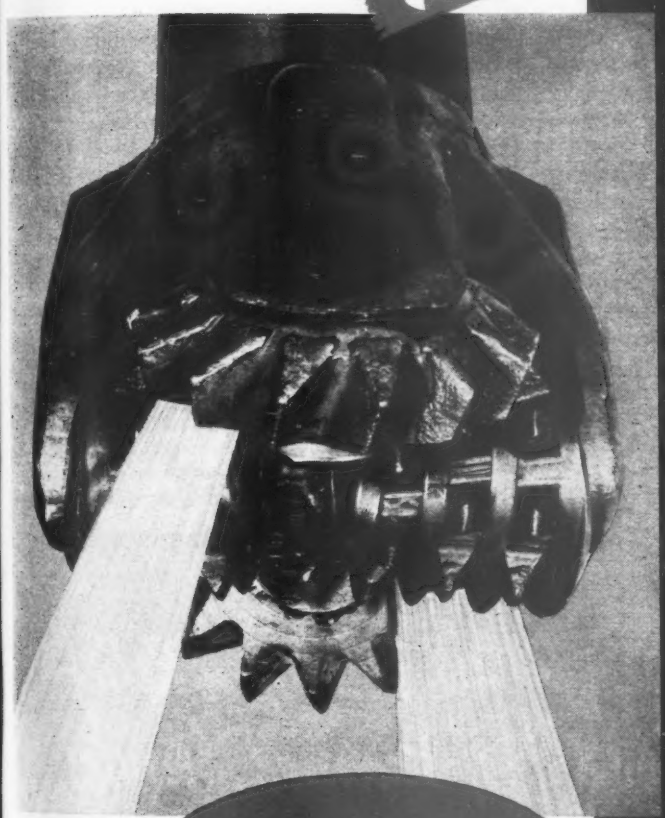

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ROCK HARDNESS AS A FACTOR IN DRILLING PROBLEMS

A survey of the technical literature concerned with oil well drilling methods and particularly with the rate of penetration by various cutting media on different types of rock yields a mass of conflicting data.

In rotary drilling, the comprehensive strength of a rock is considered as a measure of rock hardness, while in cable-tool or percussion drilling, the resistance to indentation or impact is employed as the yard-stick of rock hardness; on the other hand, in diamond drilling, resistance to abrasion is utilized as the guage of rock hardness. There exist serious discrepancies arising from the employment of these various devices as a measure of one of the principal physical properties of rock.

Other physical properties such as elasticity, tensile strength, crystal orientation, degree of cementation and effect of variations in mineral content also are of vital importance in rock penetration and should be ascertained before more efficient drilling methods can be developed. In addition, there are changes in the physical properties of rock buried at a depth of several thousand feet, and these have a profound effect in deep oil well drilling.

Since information on the physical properties of rock would be of greatest benefit to the petroleum industry, it is recommended that the industry sponsor a research program to obtain this information which would prove of vital significance in the development of new drilling techniques.

Abstract of an address presented February 14, 1590, at the New York Annual Meeting of American Institute of Mining and Metallurgical Engineers, by Dr. W. B. Mather, chairman of Mineral Technology, Southwest Research Institute, San Antonio.

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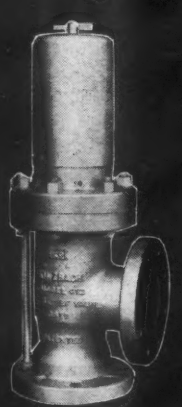

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Reservoir Performance in Leduc Field

Pressure declining slowly—Withdrawal rate changes little—Gas oil ratio trends are irregular—Extension in D-3 structure important

LESLIE O. ROLAND

PRESSURE decline in the wells producing from the gas-capped D-3 Devonian zone of the Leduc oil field has not been as great as was predicted in the early development of the field, according to the latest revised graphs of reservoir performance issued by the Alberta Conservation Board. Pressures were disturbed severely by the blowout of the Atlantic No. 3 well nearly two years ago, but after several months of great fluctuation, mostly downward, the trend has settled to an apparently steady, slow decline. During the nine months preceding last December 1, the latest charted date, the average decline has been about 1.6 psig for the entire group of about 150 wells at the beginning of the period and 230 at the end.

The development rate was slowed down substantially since December. Only 15 new wells were completed in both producing zones during December and January, and three dry holes were abandoned.

Bottom hole pressures averaged about 1900 psig at the beginning and the average is still above 1800 psig. The pressures are very uniform throughout the zone, and there are no relatively low pressure areas in the reservoir, due to high permeability of the coral reef structure. Bottom hole pressures equalize rapidly and individual wells have high productivity indices.

The D-3 zone withdrawal rate averaged between 600,000 and 700,000 bbl per month during the latter half of 1949. There was very little increase in total withdrawals in that period, because voluntary proration of production on account of scarcity of markets forced all producers to curtail individual wells as the number of producing wells increased. This situation is expected to continue for some time, although it will be less troublesome now that the Leduc field is nearing maturity. Current drilling activity is more or less limited to offsets required for conservation safety and to extension tests around the fringes of the proved area. Current production allowables are 80 bbl per day for D-3 zone and 55 bbl per day for D-2 zone wells. Conservation Board allowables would permit 115 and 75 bbl per day, respectively, if the markets were available.

In the D-2 zone, the quantity of data available on bottom hole pressure variations has been more limited than in some of the other more permeable pools, according to the Conservation Board. No attempt is made in the charts to average the field, as pressure differentials have amounted to as much as 250 psig. The individual wells are affected by the nature of the reservoir, with its irregular depth of porosity and varying permeability. Studies of individual D-2 zone wells indicate that the older wells had declined to a range of from 1475 to 1575 psig by the first of December from the initial reservoir pressure of 1760 psig. This range was applicable to wells that had produced at least 50,000 bbl of oil. The Board engineers have estimated that the average decline rate is about 3 psig per 1000 bbl of stock tank oil produced. Recently drilled wells in the D-2 zone (mostly in the southwest and south portions of the proved area) have shown somewhat higher pressures than 1575 psig.

It is difficult to estimate the flowing life of wells in either zone. The existence of a combination gas cap and water drive in the D-3 zone should, however, give it a much longer primary recovery life than the D-2 zone, which apparently lacks both. Gas-lift producing methods are being studied.

Gas-oil ratios in the Leduc field show an irregular trend for both zones, with the D-3 much more erratic. The average for the D-3 zone is about 600 cu ft per bbl. The D-2 zone average is a little higher. Several wells in the D-3 zone produce with a gas-oil ratio of about 700 cu ft per bbl, while about 35 wells in the D-2 zone are above 700. Cumulative average for the D-3 zone from the beginning to December 1 was about 570 cu ft per bbl. The cumulative production from the D-3 zone was about 11,000,000 bbl on December 1, 1949.

Most interesting subsurface development of the past two months has been the rise in the D-3 structure to the west of the central and northern portion of the field, possibly opening up an important extension. The initial extension well, Ross Petroleums Leduc No. 1, found oil in the D-2 zone on its location about four miles due west and a little south of the Imperial discovery well and a quarter-mile west of the four oil wells drilled by Flank Petroleums on the Imperial farmout. This well showed an initial potential of 720 bbl per day.

The second well, Ross No. 2, found oil in the D-2 about mid-December. It was a quarter of a mile west of the No. 1. Drilling on, it found the D-3 zone 33 ft above the usual water level, which is about 3020 ft subsea. This well was about 63 ft higher on the D-3 than the McConset No. 1, well, which was drilled three-eighths of a mile northeast, and found the D-3 zone was water-bearing. The D-2 zone was about 25 ft higher, hence the decision to seek a rise in the D-3.

Ross No. 2 halted 19 ft in the D-3 zone, jet-perforated after setting a liner from the bottom of the casing to the total depth, and obtained an initial potential of 874 bbl per day. Ross No. 3 was drilled one-quarter of a mile north, but, due to the irregular nature of coral reef structures, this well missed the edge of the reef and was abandoned. The D-3 zone may continue to rise to the west, however, in this area. All adjacent acreage to the west and southwest is held by Imperial Oil.

The shape of the coral reef structure at Golden Spike that gave Imperial Oil the biggest well ever completed in North America less than a year ago is being determined gradually. Three wells have now been completed, but not much is known yet about the extent of the structure. The latest well

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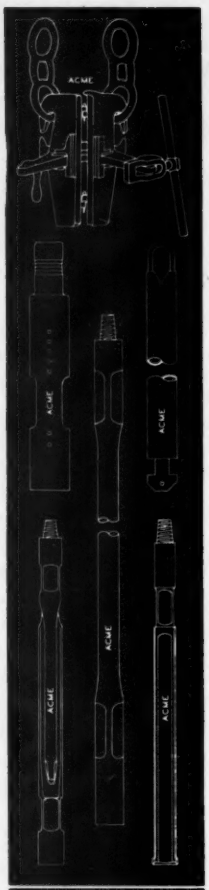

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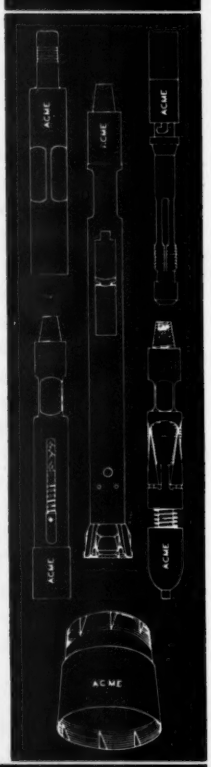

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found about 20 ft more porosity than the discovery well, which is one-half mile due south. The discovery well had about 545 ft of pay zone. The new well, No. 5, had about 560 ft. No water level has been established in any of the five wells drilled so far.

Well No. 4, one-half mile east of No. 5, found the D-3 zone top a foot higher than the discovery well and had about 546 ft of pay section. Well No. 5 topped the D-3 zone at 5366 ft, or 3031 ft subsea. The discovery well had the top at 3026 ft subsea. Well No. 5 brought another surprise for the company. It found a good showing of crude oil in the higher formation, the D-2 zone, which was present in both the discovery and the No. 4 well, but was too tight to produce. Further exploratory drilling in the D-2 is planned as more wells are staked. Five drillstem tests were run in this zone on the way down, covering depths from 2664 ft subsea to 2842 ft subsea. The first 88 ft tested brought a strong flow of oil to the surface in 14 min; the bottom 30 ft of this interval brought oil flow to the surface in 16 min. Lower intervals were tight and the impervious Green Shale zone was found below for about 189 ft above the D-3 top.

Production technique is to set casing to a point about 16 ft above the D-3 top, drill into and through the pay zone, and plugback to a point a short distance below the base of the pay zone. The zone is opened then by acidizing, and no more casing is set.

New stepout wells should indicate the shape of both the D-3 and D-2 producing zones. The first two stepouts, drilled last summer about 2½ and 3 miles northwest and northeast of the discovery, were both dry and neither found any trace of the reef formation. The problem now is to define the reef boundaries with as few failures as possible, hence the cautious one-quarter and one-half-mile extension tests. The most recent is Imperial Golden Spike No. 6, now drilling at a location about a mile southwest of No. 5 and three-quarters of a mile southwest of the discovery. The results that come from it are expected to set the pattern for the following tests.

Imperial production men and field geologists believe the coral reef in this area may be a sort of high plateau like a pillar with a sheer drop-off all around a fairly small producing area. The absence of any apparent water level lends some credence to this opinion, although it is not yet clear why the top of the D-3 was found several hundred feet below its level in the Woodbend field just five miles east.

* * *

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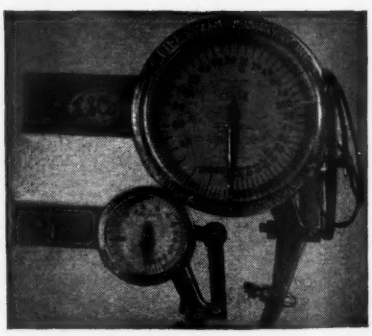

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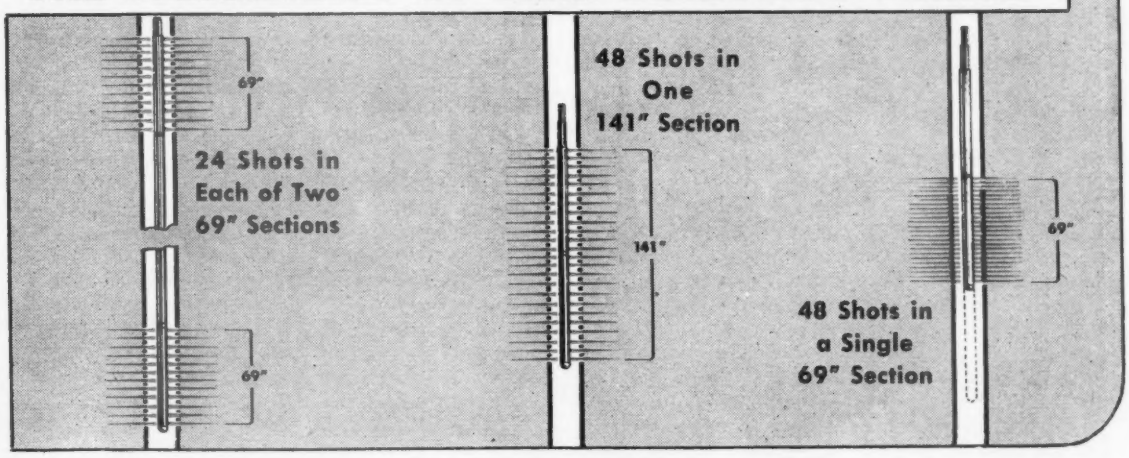

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NEWS

AIME Elects Officers At Dallas Meeting

About 60 members and guests of the American Institute of Mining and Metallurgical Engineers gathered at the Melrose Hotel in Dallas, Texas recently to participate in the election of officers to serve during 1950, and to hear a talk entitled, "The Trends of Socialism in Great Britain," by Lewis E. Young, president of AIME.

Charlie Carpenter, nominating committee chairman, presented the committee's nominations for new officers, and all candidates named were elected by ballot. Roland Gouldy, Bridwell Oil Company, Wichita Falls, was elected chairman; vice chairmen selected were William E. Stiles, Core Laboratories, Inc., Dallas; Patrick Reardon, Gulf Oil Corporation, Fort Worth, and R. G. Parker, Continental Oil, Wichita Falls. Sam DeWitt, Seaboard Oil Company, Dallas, was elected secretary-treasurer.

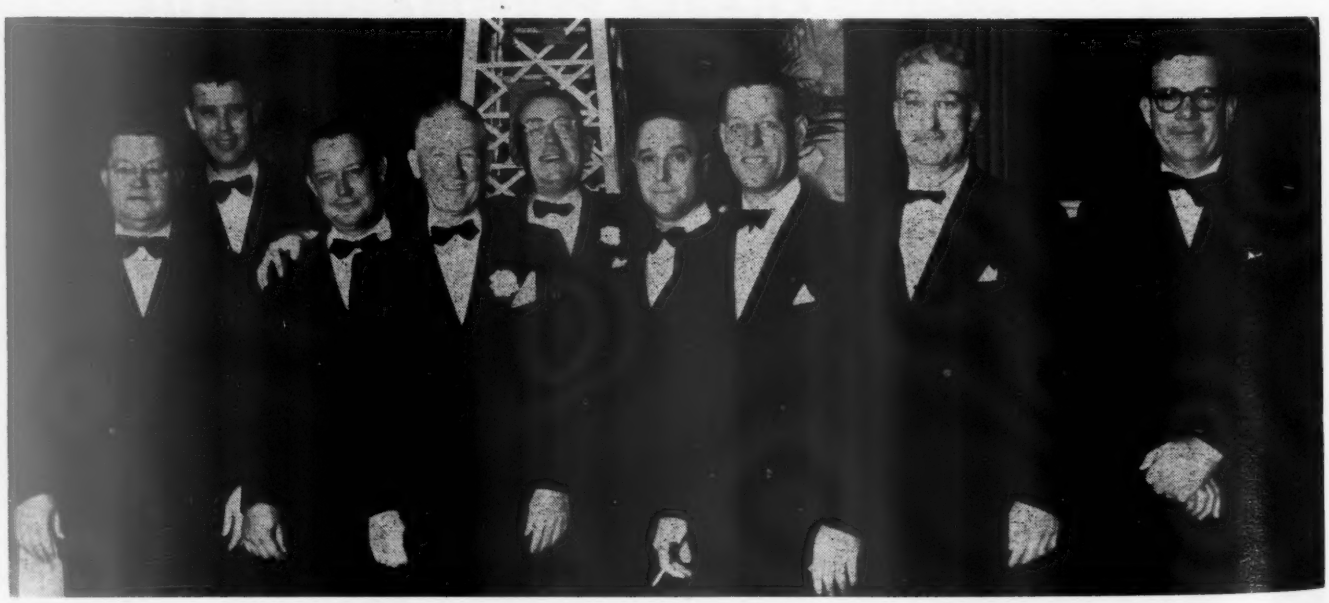
Directors named for 1950 were retiring chairman, Don L. Harlan, The Texas Company, Fort Worth; Jack A. Crichton, DeGolyer and MacNaughton, Dallas; Warren J. Jackson, Lane-Wells, Dallas; Charles H. Pishny, Cummins, Berger and Pishny, Fort Worth; John R. Evans, Stanolind Oil and Gas, Fort Worth, and I. E. Curtis, Hull-Silk Engineering Committee, Wichita Falls.

AIME Officers for 1950—Officers elected at a recent AIME meeting in Dallas, are, seated: Jack A. Chrichton, Don, L. Harlan, I. E. Curtis, Warren J. Jackson, and Sam Dewitt. Standing: Patrick Reardon, William E. Stiles, Roland Gouldy, and R. G. Parker.

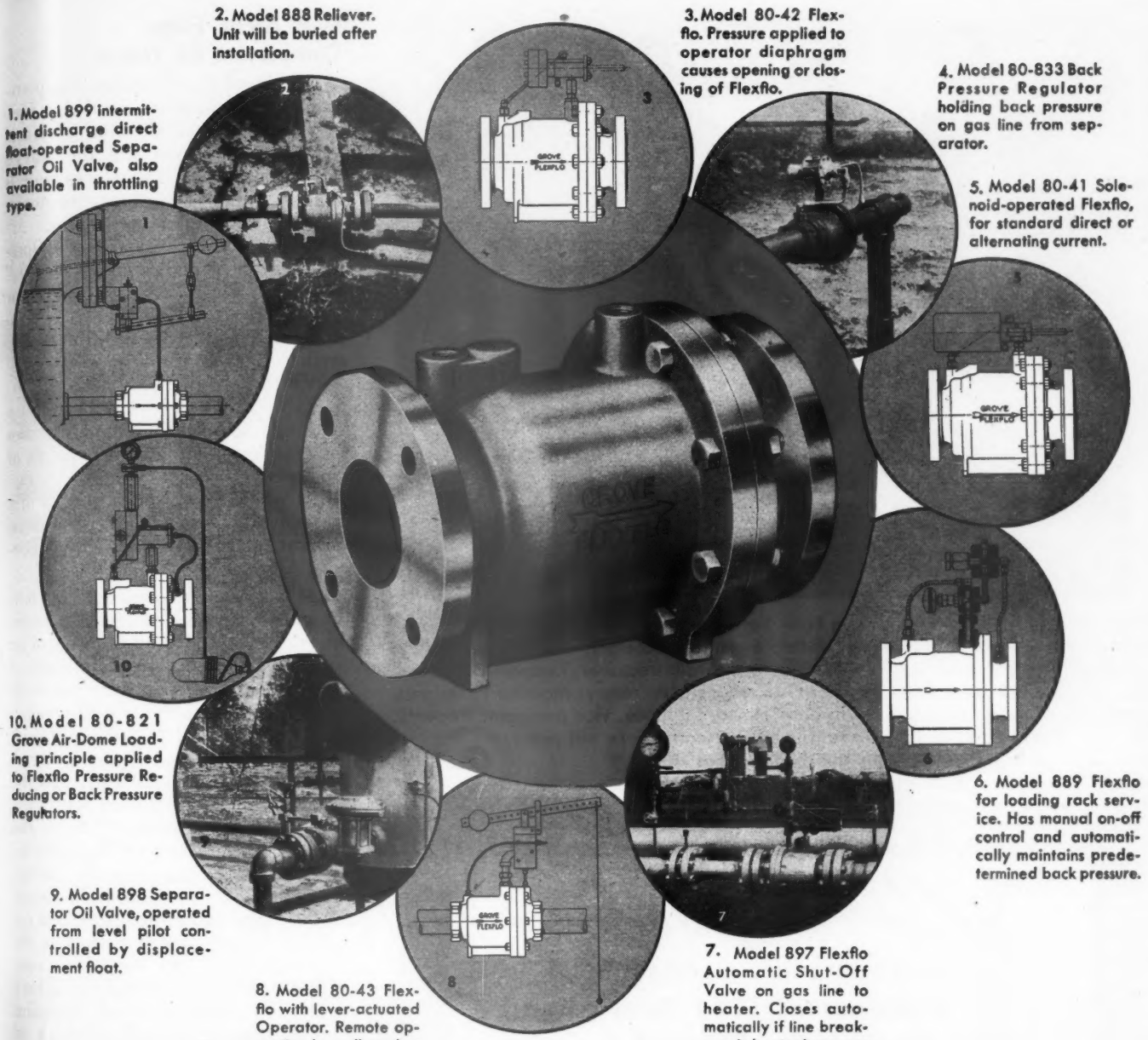
AIOC-Pacific Western Complete First Neutral Zone Test

American Independent Oil Company has announced that its joint program with Pacific Western Oil Corporation for the determination of the structural features of the Kuwait-Saudi Arabian Neutral Zone and for the testing for oil of such structures as may be situated, is proceeding on schedule.

The first structural test well has been completed. It was situated some 16 miles South of the Kuwait border and was carried deep enough to obtain electric log correlations with the Burghan oil field wells 20 to 25 miles to the North. These indicated that the number one test was probably on the East flank of a structure running North and South.



The Houston Nomads held their election of officers recently. They were officially installed at the annual Nomad dinner dance held at the Shamrock Hotel with more than 550 Nomads and guests in attendance. New officers for 1950, left to right, are: C. B. McDonald, regent, A-1 Bit and Tool Company; Lawrence J. Kelley, sergeant-at-arms, Hillman-Kelley; Wayne Rives, vice president, The Oil and Gas Journal; Edmond L. Lorehn, president, Cameron Iron Works; C. F. (Bud) Vincent, deputy sergeant-at-arms, Byron-Jackson; E. F. (Salty) Baldwin, assistant secretary-treasurer, Hughes Tool Company; E. M. Fontaine, regent, National Tank; Tracey T. Word, Jr., secretary-treasurer, Weco; H. E. Estes, executive secretary, A-1 Bit and Tool.



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8. Model 80-43 Flexflo with lever-actuated Operator. Remote operation by pull-cord or chain.

9. Model 898 Separator Oil Valve, operated from level pilot controlled by displacement float.

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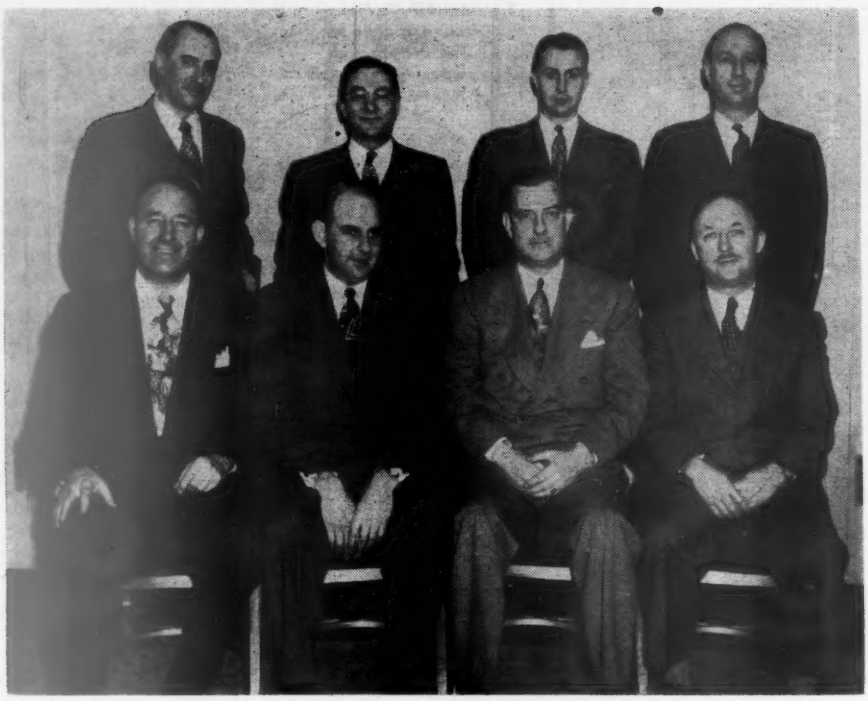
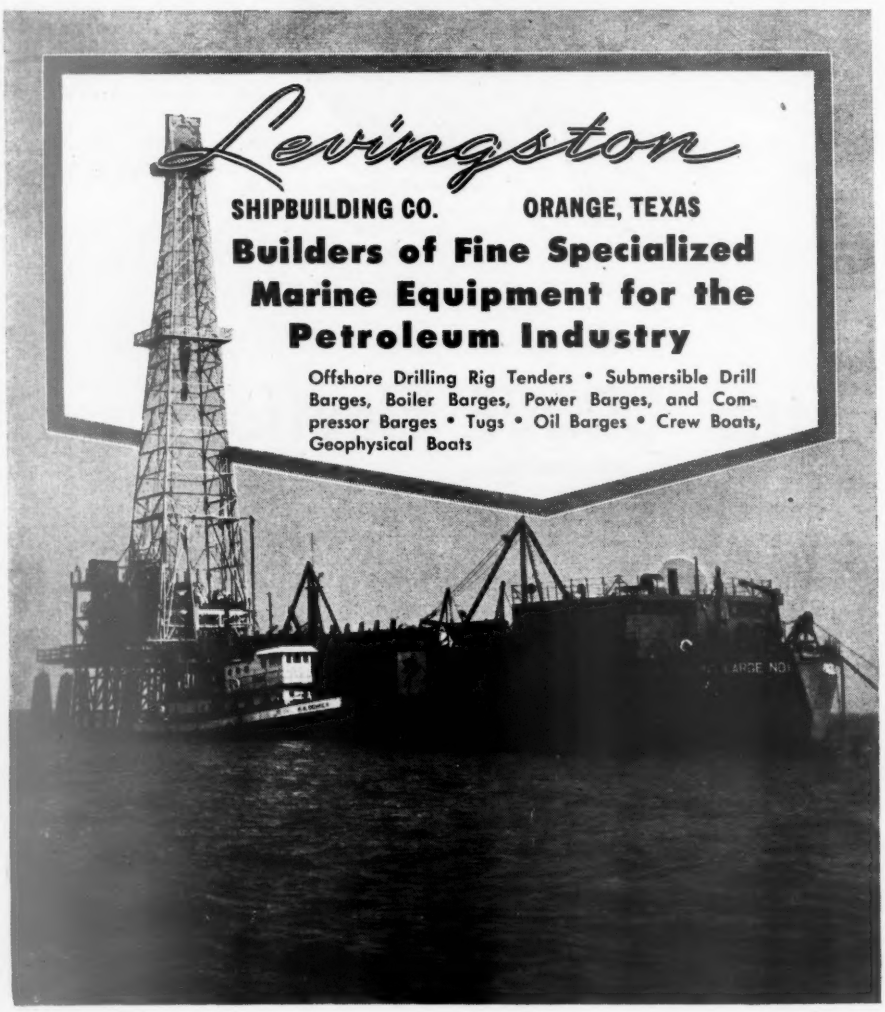


Officers elected for 1950 for the New York Chapter of Nomads are as follows: Back row, left to right: Fred J. Jobst, assistant secretary; Eugene R. Smoley, assistant sergeant-at-arms; John D. Evans, assistant treasurer; Kenneth D. Demarest, sergeant-at-arms. Front row: Ed T. Landgraff, secretary; Maurice F. Delano, treasurer; Henry J. McAdams, president; Howard B. Book, vice president. Regents, Val R. Wittich, Jr. and Russell D. Heath, were not present when this picture was taken.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Five Arctic Films Completed By Navy

A series of five films showing petroleum operations in the Arctic has been completed by the director of Naval Petroleum Reserves and the Navy's Bureau of Yards and Docks and is available for showing before engineering societies and similar groups.

Entitled "U. S. Naval Arctic Operations (Petroleum Reserve No. 4)," the films are in 16 mm sound and color and are designed for the indoctrination and information of military and civilian personnel who may be assigned for duty in the Arctic.

"MN-5377A-Introduction" has a running time of 30 min and discusses the general topography and climate of Northern Alaska.

"MN-5377B-Logistics" runs 25 min and covers the methods of logistic support of the base camp, Point Barrow, Alaska.

"MN-5377C-Exploring for Oil" tells the geological and geophysical methods of exploring for oil in terms of an Arctic expedition. The techniques of core-hole drilling and deep test well-drilling are discussed and illustrated. Among the surveying methods considered are those using the aerial magnetometer, the gravity meter, and the seismograph. Running time is 35 min.

"MN-5377D-Equipment" shows the types of equipment used in construction and transportation in the Arctic.

"MN-5377E-Construction" discusses the many and varied problems encountered in construction work in the Arctic and how they have been met.

These films are available on a loan basis from District Naval Training Aids Libraries, through members of the U. S. Naval Civil Engineer Corps Reserve, or prints may be purchased through the U. S. Board of Education.

Offshore Drilling Movie Available

"Neptune's Oil Fields", a 27-minute sound and color motion picture of offshore drilling, just completed by Kerr-McGee Oil Industries, Inc., is now available for public showing, according to Dean A. McGee, executive vice president.

The picture was filmed in the Louisiana Gulf and shows all activities connected with tidelands drilling from location of the structures by seismograph, through the designing of drilling tenders, platform construction and equipment testing, to the actual drilling and producing operations.

Oil and gas groups, civic clubs, engineering and geological societies, and college classes may obtain prints of the film for free showing by writing the Kerr-McGee office, Oklahoma City.

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3. Lower Casing Head and Rolled "Boll Weevil" Casing Hanger, Type "A3," Gray Patent Pending.

Patents

4. Lower Casing Head and Control Type "Boll Weevil" Casing Hanger, Type "A4," Gray Patent No. 2,485,497.
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6. Foundation Type Casing Head, Gray Patent No. 2,207,471.

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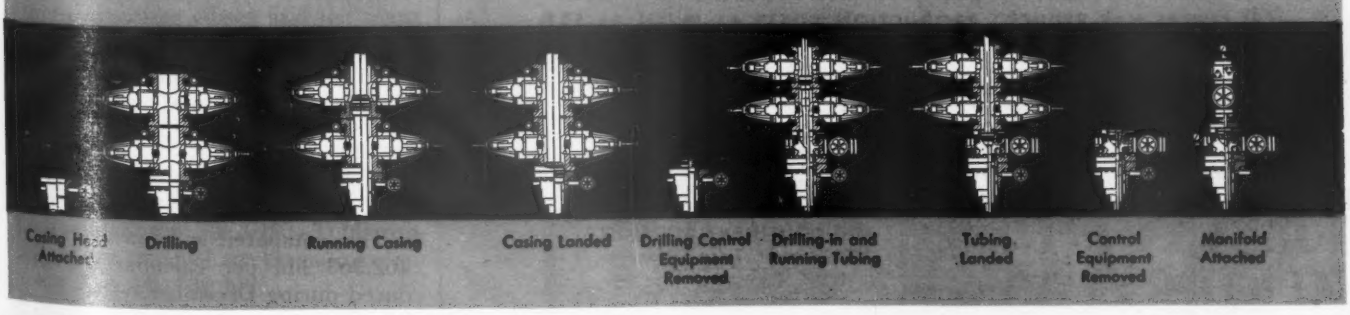

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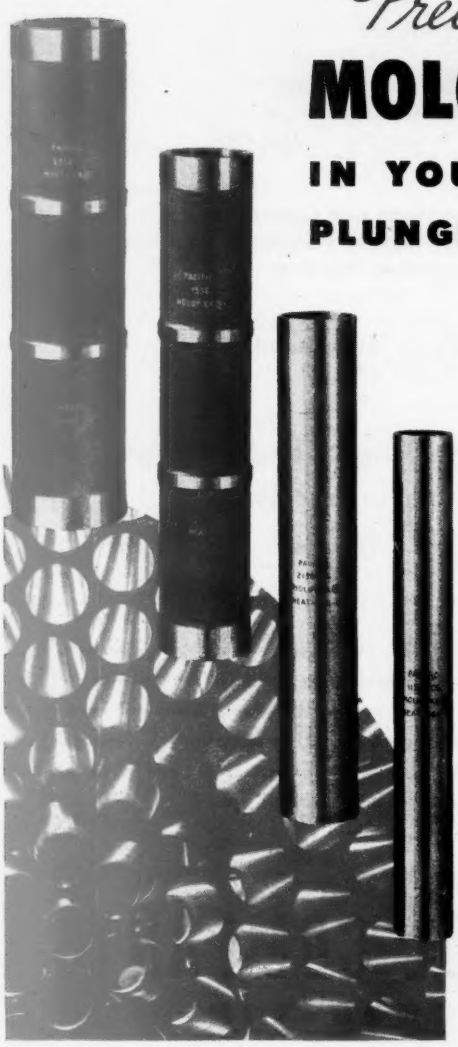

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Organize New Drilling Firm

B B M Drilling Company, a new concern, has been recently organized in Houston, Texas, to do business in Mid-Continent and Southwest oil areas, headed by Frank J. Whitley, co-

Frank J. Whitley

owner, as vice president and general manager.

B B M Drilling Company presently has four drilling rigs, three power and one steam, capable of drilling all depths down to 15,000 ft. Three of the rigs were acquired from Barnsdall Oil Company along with tool pushers and all crews that have been in continuous employment on these rigs for several years. At the present time, B B M has drilling operations in Western Oklahoma, West Texas, and Old Ocean Field of the Gulf Coast of Texas.

Whitley resigned his former position of assistant to vice president and manager of operations of J. S. Abercrombie Company, Houston, Texas. He was graduated from Georgia Tech.

Other officers of B B M Drilling Company are Paul F. Barnhart, president, Houston, Texas and David G. Baird, vice president, New York, New York. V. V. "Doolittle" Thomasson is drilling superintendent at B B M's West Texas office, Snyder, Texas. Thomasson was formerly with Barnsdall Oil Company as assistant drilling superintendent for a number of years. Tool pushers for the new concern are Jake B. Waltermire, Bay City, Texas, and A. P. "Dutch" Hegenheiser, Snyder, Texas.

Principal offices of B B M are located in the Esperson Building, Houston, Texas.

Production In Saudi Arabia

Crude oil production in Saudi Arabia during January amounted to 13,947,930 bbl, or an average of 449,933 bbl per calendar day, it was announced by the Arabian American Oil Company.

This compared with an average of 462,363 bbl per calendar day produced during December.

Texas Revises Proration

A new formula for proration of Texas oil wells has been set up by the Railroad Commission. It is similar to the plan used briefly in 1947.

The table below shows how many barrels daily each Texas well can produce during the seventeen flow days in March under the Railroad Commission's "1947 yardstick" formula based on hole depth and proration units:

Depth	10 Acres	20 Acres	40 Acres
0- 1,000	18	28	.....
1,000- 1,500	27	37	57
1,500- 2,000	36	46	66
2,000- 3,000	45	55	75
3,000- 4,000	54	64	84
4,000- 5,000	63	73	93
5,000- 6,000	72	82	102
6,000- 7,000	81	91	111
7,000- 8,000	91	101	121
8,000- 8,500	103	113	133
8,500- 9,000	112	122	142
9,000- 9,500	127	137	157
9,500-10,000	152	162	182
10,000-10,500	190	200	220
10,500-11,000	.....	220	220
11,000-11,500	.....	.....	260
11,500-12,000	.....	.....	260
12,000-12,500	.....	.....	280
12,500-13,000	.....	.....	280
13,000-13,500	.....	.....	300
13,500-14,500	.....	.....	300

Ohio Oil Completes New Crude Oil Division Office

Ohio Oil Company has completed its new crude oil producing division office building at 650 Cherry Street in Terre Haute, Indiana. Open house was held February 27, and visitors were shown through the building.

The recently-completed structure is headquarters for Ohio's crude oil producing operations in Illinois, Indiana, Ohio, Michigan, Kentucky, Tennessee, Pennsylvania, Virginia, and West Virginia. Erection of the building followed the recent consolidation of four of the company's eastern producing divisions, which made the construction of larger quarters necessary.

Behind the 120-ft limestone facade, the two-story reinforced concrete and masonry structure has a gross floor space area of 25,500 sq ft. The building provides ample room for the division's executive offices and the many departments that comprise the headquarters.

Venezuelan Production

The Colon Development Company, Ltd. produced 344,712 bbl of crude oil in Venezuela for the four weeks ending January 30, 1950. Total produced for the five weeks ending January 2. is 440,040 bbl.

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the *best* method for accurately surveying tubing for corrosion *under pressure, without killing the well, or pulling the string for surface inspection*

Internal corrosion causes the tubing string in hundreds of gas-condensate wells to leak, collapse, or, in some cases, the complete loss of the well. An accurate, dependable survey of the true internal condition of the tubing, furnished by OTIS — *the industry's leading authority on tubing corrosion analysis* — often can prevent untold dollars' worth of expensive salvaging operations or the loss of hundreds of barrels of valuable oil. ✶ Contact the Otis office nearest you for complete, factual information, and your copy of "Report of Tubing Corrosion Survey." Let our engineers explain how your wells can be calipered at a minimum of production down-time because, among other reasons, experienced Otis wire-line crews **1** run the Otis Tubing Caliper at a rate of 30,000 feet per day; **2** caliper a well *under pressure*, without pulling the string; **3** make a preliminary, on-location expert analysis if necessary.

Closely-spaced spring-loaded feelers press against the inside area of the tubing wall; when a corrosion pit is encountered, direct action causes a rotating stylus to plot the location on a metal chart inside of the Caliper. The depth of the pits determines the extent of the log marks plotted by the stylus.

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WHAT'S DOING IN DRILLING

Imperial Plans Six New Redwater Wells

Imperial Oil Ltd. has chosen sites for six new development wells in the Redwater oil field in Calgary, Canada. All six wells are offsets to current production, and will be begun as soon as possible. In addition to staking the six new locations, Imperial has completed another field development well, its 118th. The new well is Redwater No. 65, completed at 3222 ft.

Skelly Wells Flow 100 Bbl an Hour

Three wells have been completed for a flow of 100 bbl of oil an hour or more on each in Scurry County, Texas, by Skelly Oil Company. Skelly No. 1 Harral flowed 677 bbl of oil in 6 hr through a 1-in. choke, for a 24-hr potential of 2708 bbl. Total depth is 6772 ft. Harral No. 2 flowed 801 bbl of oil in 6 hr through 1-in. choke, total depth, 6832 ft. No. 3 Harral flowed 600 bbl in 6 hr through 1-in. choke, with a total depth of 6825 ft.

Canadian Gulf Completes Third Stettler Producer

Canadian Gulf Company has completed its third Stettler producer with its Ellis No. 13, 100 miles northwest of Calgary. The new well, an offset to the discovery well, was completed in the D-3 of the Devonian at 5377 ft and is now waiting for an initial potential test. Discovery of the No. 13 well found 150 ft of oil bearing zone, 50 ft of which was in the D-3.

Well Flows 650 Bbl in 24 hr

Shell Oil Company has completed another producer in the Beckham County, Oklahoma, sector of the Elk City field. Its No. 1 Oklahoma State "D" flowed 650 bbl of high gravity oil, with 950,000 cu ft of gas, in 24 hr through an 18/64-in. choke. It is moving out rotary. Plugged back depth is 9970 ft.

Sinclair Well Flows 777 Bbl in 15 Hr

Sinclair Oil and Gas Company has completed a large producer in the Southwest Antioch pool of Garvin County, Oklahoma. Its No. 2 Stephens, total depth 6935 ft, flowed 777 bbl of 43.6 gravity oil in 15 hr through various chokes.

Production is from the Gibson sand through perforations between 6761-81 ft and between 6799-6820 ft.

Rotary rigs operating in oil fields of the United States and Canada.*

February Weeks	Total	Gulf Coast	Pacific Coast	Oklahoma, Kansas	Arkansas, Louisiana, Texas	Illinois	Rocky Mountain, Canada	New Mexico West Texas
1st	1948	491	139	322	130	56	125	685
2nd	1970	480	140	338	135	57	137	683
3rd	1961	486	135	327	128	60	144	681
4th	2010	501	141	356	140	57	143	672

*Figures released by American Association of Oilwell Drilling Contractors, as reported to them from Hughes Tool Company.

Drilling In Ohio Drops In 1949

A total of 1052 wells were reported drilled in search of new oil and gas production in 46 Ohio counties during 1949. According to John H. Melvin, state geologist, of this number 626 were successful and 426 were dry holes, an average of 40 per cent failures. The new reserves, on the basis of initial deliveries, amounted to 215,883,000 cu ft of gas, and 8568 bbl of oil per day.

Gas was found in 292 wells in 27 counties with initial reported open-flows totaling 197,531,000 cu ft per day. In 22 counties 254 new oil wells produced 7000 bbl of oil during the first 24 hours after completion.

The largest gas well drilled during the year was the National Gas and Oil Corporation No. 1 C. G. Longshore, Muskingum County, with reported initial open-flow of 10,416,000 cu ft natural and 850 lb rock pressure.

Largest producer was the Preston Oil Company No. 1 H. C. Albert, Perry County, which produced 275 bbl the first 24 hours after shot.

The 1949 figures when compared with those of 1948 indicated a drop in the number of wells drilled and oil and gas production. In 1948 there were 1231 wells drilled, of which 376 were gas wells, 277 oil wells, 114 oil and gas wells, and 464 dry holes, or 38 per cent failures. The gas wells accounted for 302,334,000 cu ft per day; the oil wells 7590 bbl per day, and the combination resulted in 29,518,000 cu ft of gas and 2671 bbl of oil per day.

Hunt Completes Louisiana Well

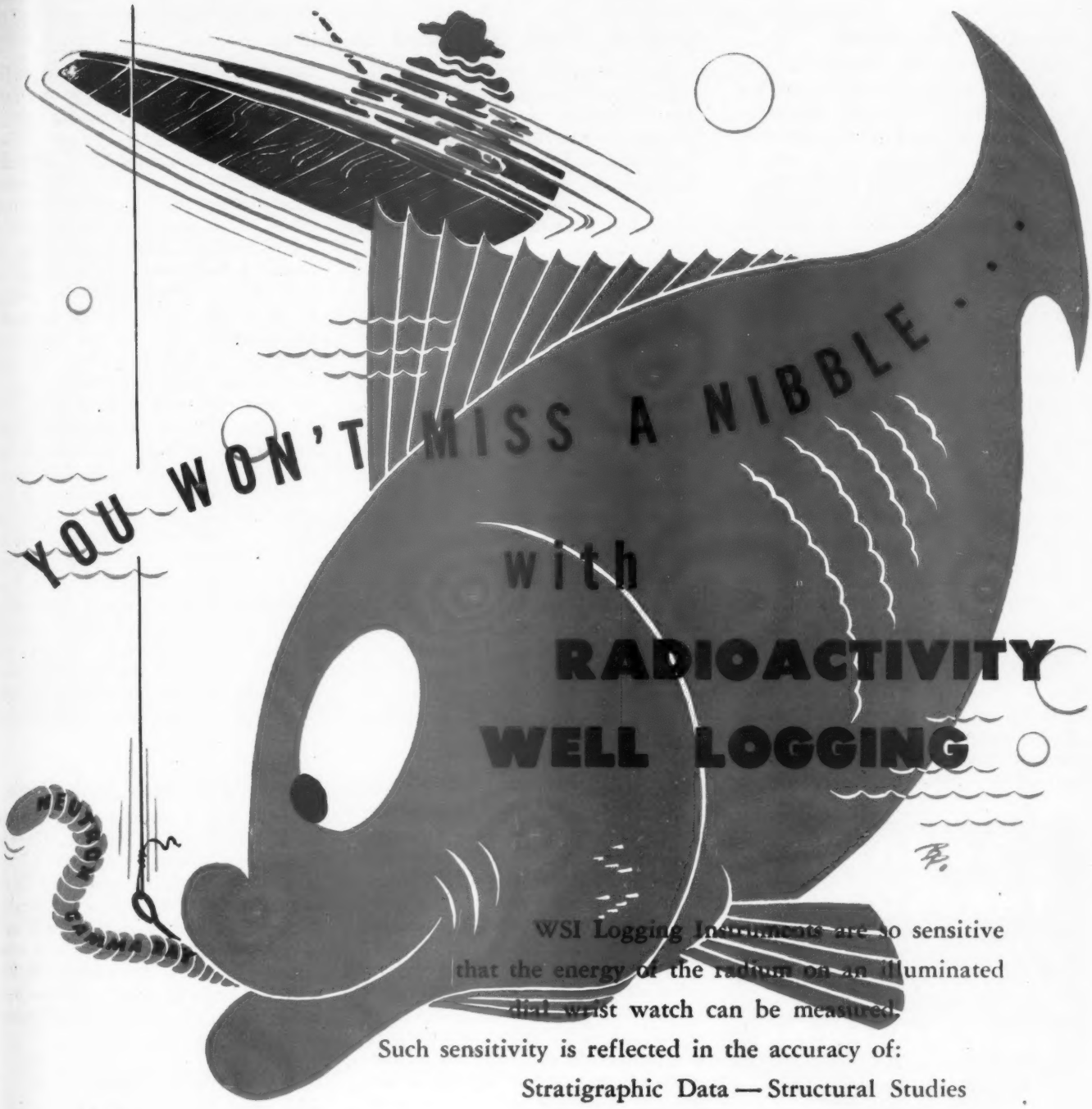
Hunt Oil Company has completed its Hassie Hunt Trust No. 1 Robinson, discovery well in the Maxie area of Acadia Parish, South Louisiana. The well flowed 40 bbl of condensate daily through 8/64-in. choke plus 95,000 ft of gas from 10,637-40 ft.

Sinclair Gets 2 New Wells

Sinclair Oil and Gas Company has completed two good oil producers in Stephens County, Oklahoma. The company's No. 6 Haines swabbed and flowed 295 bbl of 26 gravity oil in 17 hr through a ¾-in. choke from the Springer sand, from a depth of 6966 ft. The well had a gas flow of 175,000 cu ft a day with a gas-oil ratio of 412.

No. 7 Haines, with a total depth of 6231 ft, swabbed and flowed 395 bbl of 27.6 gravity oil from the Springer sand in 23 hr through a ¾-in. choke with 300,000 cu ft of gas.

Repair Damaged Wells—Pete LaPorte and George Kinslow on the Terminal Drilling Company crew after the rock bit has been pulled after opening 1831 ft of 17-in. hole to 26 in., during which time it drilled as fast as 100 ft per hour. The company is repairing several Union Pacific wells damaged by an earthquake recently. The bit is a type "S-2C" manufactured by the Globe Oil Tools Company, and is a record size 2-cutter. Work is under direction of T. P. "Mick" Prendergast, superintendent.



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Goodhue Well Flows 200 Bbl of Oil Daily

John B. Goodhue et al No. 1 First National Bank of Orange, Texas has been completed as a gas-distillate producer. It is producing at the rate of nearly 200 bbl of high gravity distillate daily through 1/8-in. choke with 3500 lb of tubing pressure. Production was reported from four feet of sand at between 8200 and 8300 ft. As yet it has not been determined whether production is from a new field or an extension.

House Organ Award

The Monthly Tour, house organ of Thomas P. Pike Drilling Company, has won recognition from Freedom's Foundation, Inc., an organization which makes yearly awards for the most outstanding jobs toward bringing a better understanding of our way of life. On February 13th, an honor medal was awarded to the *Monthly Tour* in Los Angeles. The presentation of the medal was made by Reese Taylor, president of Union Oil Company, at a meeting of Freedom's Foundation, held under the auspices of the Advertising Club of Hollywood. Miss Ann Taylor, one of the editors, accepted the award in behalf of the company.

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Drilling Fluid Discussed at AIME

The American Association of Mechanical and Metallurgical Engineers, Junior Section of the Pacific Coast Chapter, at Rio Hondo Club, Downey, California, in February, to hear W. T. Cardwell, Jr. of Cal Research Corporation discourse on "Drilling Fluid Viscosity Measurements and Their Application".

Cardwell, a graduate of the California Institute of Technology in chemical engineering, was introduced by Norman B. Clark, chairman. He is engaged in drilling and production engineering research for the California Research Corporation. Recently he has been working on drilling problems with particular emphasis on drilling fluid viscosities. Drilling fluid viscosities are something that we will need to know more about if deep holes are going to be drilled successfully in the next 5-10 years.

Drilling fluid viscosities are not instrumental quantities, but rather a property of the elements of the fluid of which we are dealing. A fluid is distinguished from a solid in that it can readily be sheared. There is some resistance to shearing in all fluids and this force is called viscosity. The speaker defined viscosity as the ratio of shearing stress to shearing rate.

Cardwell next displayed some actual curves of drilling fluids at equilibrium. Bentonitic fluids displayed characteristics more nearly like water than field muds which are associated with high gell strengths. Drilling problems affected by viscosity were discussed next. The swabbing effect of pulling the drill pipe out of the hole is caused by a pressure drop at the bottom of the hole which occurs when the drilling fluid shearing rate does not reduce the shearing stress in proportion. The opposite of this effect takes place when running in the hole. Viscosity is important to a small extent in bringing cuttings up to the surface. It is generally believed that large chunks of shale are more readily brought up by higher viscosities. The high shearing rates present in normal drilling fluid flow cause it to act like a Newtonian fluid. The important variables affecting cuttings return are density and velocity. Most of the pressure loss, about 80 per cent, in a mud circulation system occurs in the drill pipe.

Announces New Well Tubing

Another advance in the war on corrosion of field equipment is underway with oil well tubing following the combined development of a tough, impervious, and durable plastic coating, and of a method of producing a good bond between coating and metal. After 10 years of research* plus successful applications that have given worthwhile increases in the life of drill pipe under conditions of corrosion fatigue, plastic coated well tubing is showing considerable promise in producing savings of materials and maintenance expense.

A few of the results of field experience with this plastic coated tubing have become available. In West Texas a major producer and refiner has used it in the production of sour crude containing hydrogen sulfide. Two years after installation, the plastic-coated tubing is still in service. Uncoated strings have been replaced about every six months.

*Spang-Chalfant Division, National Supply Company.

Union Well Re-Drilled

Union Oil Company has completed its Bell No. 107 in the Santa Fe Springs field, in the Los Angeles, California, Basin, at a re-drilled depth of 7900 ft. The venture was designed as a deep test of the field and was carried originally to 13,541 ft.

Skelly Well May Link Pools

Skelly Oil Company has plugged back its No. 1 Johnston, Garvin County, Oklahoma, to a depth of 7555 ft. The well flowed 55 bbl of oil in 10 hours through a 9/64-in. choke and is testing. The well is on the north side of the Southwest Antioch and may form a connecting link with the Southwest Maysville pool. On previous test. it flowed 133 bbl of oil in 19 hours through a 10/64-in. choke.

Elk City Well Flows 555 Bbl In 21 Hours

Shell Oil Company has completed a large producer in the Beckham County sector of the Elk City field in Oklahoma. It's the No. 1 Walter "C" flowing on test after flowing 555 bbl of high gravity oil, with 869,000 cu ft of gas a day, in 21 hours through a 20/64-in. choke. Plugged back depth of the new well is 9959 ft.

Ventura Well Completed

British American Oil Producing has completed a new well in the Ventura Avenue, Ventura County, California. The well, No. 17, on an 8-hr gage began at the rate of 813 bbl daily and during the last three hours of the period was flowing about 1000 bbl a day. Output was restricted by an 18/64-in. orifice. Total depth is 11,038 ft with 8⅝-in. casing set at 8328 ft.

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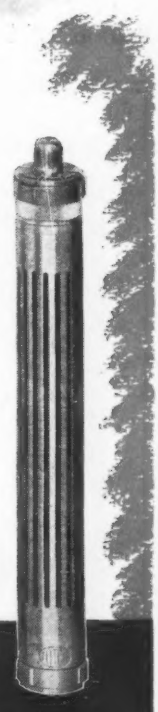
"There's nothing new in what I've said. Most drillers know all that, have known it for years, and know the value of Controlled Vertical Drilling which is easy to practise with accurate Totco records, taken at frequent intervals. That's why I can say, with certainty, that wherever men are drilling for oil, anywhere in the world, you'll find drillers keeping their wells under 2°... with a Totco."



Based upon the actual statements of hundreds of drillers and drilling superintendents in all parts of the country, and in many foreign fields.

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EXPLORATION ACTIVITIES

CIMA Well Spudded

The Mexican American Independent Oil Company (CIMA) has spudded in the second test of possible offshore production near Coatzacoalcos in the Isthmus of Tehuantepec. The first well in this area, the Tortuguero field, is producing around 200 bbl a day, but operators are having considerable difficulty with sanding. In this area, wells are drilled with derricks a short distance from the gulf shore and with the hole whipstocked out into the continental shelf area for a vertical depth of 4500 ft. The first well is producing oil of 36 gravity.

Revise Geological Text

"Subsurface Geologic Methods", compiled and edited by L. W. LeRoy, associate professor of geology, and Harry M. Crain, director of publications at the Colorado School of Mines, is being revised to meet the sales demand, according to the announcement by the Colorado School of Mines Publication Department, publishers of the book. Because of an unpredicted demand for the book, the first edition is out of print within six months after publication.

Although 4000 copies were available in the late summer of 1949, the publishers cannot fill orders until May 1, 1950, when they estimate the revised edition will be available.

Lakhra Well, Pakistan, Abandoned by Burmah Oil

The Burmah Oil Company (Pakistan Concessions) Limited, has announced its decision not to carry its oil exploration well at Lakhra any deeper. In making this announcement the Burmah Oil Company stated that at 12,666 ft large volumes of water under high pressure had been encountered. It is considered that this water comes from the reservoir rocks that were the objective of the well, and as there is no sign of oil or gas further drilling operations are pointless.

In the thick shale from 3740 ft to 12,666 ft several pockets of gas under high pressure were met. These gas shows had encouraged the hope that when the well reached reservoir rocks they would be found to contain oil or natural gas in commercial quantities. But such was not the case. The disappointment of these hopes is an unfortunate example of the risks attendant upon oil prospecting in which long adverse odds are associated with tremendous expense.

Despite the progress made in applying science to the search for oil there is still no instrument which will detect the presence of oil underground. Indeed, even now only one test well in ten is successful, on average, in locating oil in workable quantities.

Cost of drilling the Lakhra well has been estimated at about one million pounds sterling.

The Burmah Oil Company (Pakistan Concessions) Limited emphasize that careful consideration is now being given to future policy in the light of evidence obtained at Lakhra and a decision will shortly be taken as to whether further drilling should take place, either at Lakhra or elsewhere in Sind, or whether the area should be abandoned.

Open Strawn Sand

The first Strawn sand oil production in the Steed-Worsham pool of southeastern Jack County, Texas has been opened by Charlie Grace Drilling Company, Wichita Falls, with the completion of the company's No. 1 F. E. Lee. The well flowed 61 bbl of 40.2 gravity oil in 24 hours on initial potential test with pay from 3870 to 3930 ft.

Completes Wintergarden Well

Continental Oil Company has completed its No. 2 McKnight in Dimmit County, Texas, as an oil discovery for the new Wintergarden field. The well was drilled to a depth of 3310 ft and 6-in. production casing was set on bottom, and flowed 5,100,000 cu ft of gas per day on open flow, with shut-in pressure on the tubing at 1227 psi.

Humble Discovers New Field in Mississippi

A new field has been opened in Adams County, Mississippi, in the city limits of Natchez, by Humble Oil and Refining Company. Field opener is Humble's No. D-1 Mrs. C. L. S. McKittrick, which pumped at the rate of 37.8 bbl of 27 gravity oil daily. Gage was through 3/8-in. bottom choke with a tubing pressure of 20 lb and gas oil ratio of 500 to 1.

Deep Ellenburger Discovery Made In Midland County

General American Oil Company, Dallas, Texas, has a new discovery in South Midland County.

The firm's No. 1 Mrs. Hal C. Peck, about four miles west of the Pegasus area, tanked 483 bbl in 11 hr through 1-in. choke. In the last hour it made 45 bbl.

Production is coming from perforations at 13,128-250 through which 1000 gal of mud acid were injected.

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• On a routine run, JUNK-UP saved this operator a possible expensive fishing job. The JUNK-UP was run in 7" casing while reaming following a gun perforation job. The first JUNK-UP was run directly above the drill collar, the middle one three joints above and the top one four joints above the middle cup.

• HERE'S THE PROOF—This potential trouble . . . enough junk to stick the packer, prevent a test, or cause an expensive fishing job . . . was removed. The top JUNK-UP came out full, the middle cup half full and the bottom cup had a few pieces of junk in it.

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Sinclair to Drill 11,500-ft Louisiana Test

Sites have been staked for two new tests in Pointe Coupee Parish, South Louisiana. Sinclair Oil and Gas Company will drill an 11,500 ft test 8 miles north of Rosedale as the No. 1 H. M. Kimbell. The test is three and one-half miles west of Erwinville. J. P. Petkas and Associates staked their No. 1 L. K. Nicholson in the Eldorado Plantation area.

Union Oil Company of California and Kerr-McGee will drill a tidelands wildcat in Main Pass area off Plaquemines Parish.

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Texas Completes Newton Well

The Texas Company announced striking the deep Wilcox zone in Newton field, Newton County, Texas, with the completion of Newton County Lumber Company-Derrough Unit No. 1 as a producer.

On a 24-hr potential test, the well flowed 140 bbl of pipe line oil on a 12/64-in. choke. The well was drilled to a total depth of 11,500 ft, and perforations were made from 10,965 to 11,004 ft. Corrected gravity of the oil was 44.4 deg, the gas-oil ratio, 2400 to 1. Newton County Lumber Company No. 1, discovery well of the field, was brought in several months ago at 9600 ft.

Extend Scurry County Reef

George P. Livermore's Reinecke No. 1 wildcat in Southeastern Borden County, Texas, flowed 1140 bbl of oil in 19 hr through 5/8-in. choke on its initial test. The wildcat has assured a 5 1/2-mile southwest extension of the Scurry County Canyon Reef. Total depth is 6789 ft. Seven-inch casing was set at 6754 ft.

Opens Orange County Pool

A new oil pool has been opened at Orange County, Texas, in the Rose City area, by John W. Mecom, Houston. The operator's No. 1 East Beaumont Townsite Company, Stephenson league, six miles east of Beaumont, is making final gage after flowing at the rate of 18 bbl an hour through 3/16-in. choke on a drillstem test from 8122-28 ft. Tubing pressure was 1300 lb and gas-oil ratio was 700 to 1. The well is producing from the Hackberry zone of the lower Frio.

Three Wildcats Staked

Operations have begun for three 7200-ft semi-wildcats in Lea County, New Mexico just southeast of the old shallow Hobbs field by Stanolind Oil and Gas Company. The explorations are outposts to Stanolind No. 1 Foster, discovery from the Drinkard zone of the Lower Permian, which is now testing on pump to complete from 7312-560 ft. It has produced at the rate of 5 bbl of oil per hour swabbing and flowing.

New Producing Area Opened

Messmer Oil Company's No. 1 Ida Nesbitt, opens a new oil producing area in Lawrence County, Illinois, about three miles southeast of Lawrenceville. The well is on a production test of the McClosky limestone at 1890 to 1895 ft and 1915 to 1920 ft. Total depth is 1927 ft. After 5000 gal of acid, this well swabbed 175 bbl of oil and 20 bbl of water a day. It is one and a half miles from other oil wells.

Mississippi Is Given First Travis Peak Well

The first producing well in the Travis Peak in Mississippi has been discovered by the Carter Oil Company. The No. 1 J. L. Wilson is in the Pickens field of Yazoo County. It will be re-completed in the 18-ft zone of the Travis Peak that was revealed when the casing was perforated at 7732 to 7750 ft.

Book on Illinois Reefs

The Illinois State Geological Survey division has published a new book, titled "Niagaran Reefs in Illinois and Their Relations to Oil Accumulation," by H. A. Lowenstram. The booklet describes Niagaran stratigraphy, sedimentation belts, and oil possibilitities. The new publication, which includes 9 figures and 1 plate, is priced at 25 cents. Orders should be mailed to Illinois State Geological Survey, Urbana, Illinois.

Ohio Tests Nebraska Well

A new well is being drilled by Ohio Oil Company in the Huntsman area of Cheyenne County, Nebraska, and unofficial reports say this one will be drilled all the way to granite. The new test will be the No. 1 McLeron, two miles east of the discovery well, in the Huntsman field, and is believed to be on a separate structure from other Huntsman wells.

Find New Sand at Fordoche

A new sand has been opened in the Fordoche field, Pointe Coupee Parish, South Louisiana by The Texas Company. The company's No. 1 Price Unit 2, has been completed to flow 136 bbl of 39.8 gravity oil daily through 1/4-in. choke from 8868 to 8874 ft. Tubing pressure was 675 lb and gas-oil ratio was 5227 to 1.

New Pool Opened in Arkansas

C. H. Murphy and Company's No. 1 Gregory in Union County has opened a new oil pool for Arkansas. Drilled to 9500 ft, casing was cemented at 9360 ft. Perforations were made opposite sand in the Cotton Valley at 8012-22 and 8020-28 ft. The wildcat flowed at the rate of 150 bbl of oil a day through 1/4-in. choke. The well is 5 miles from any other well.

Young County Pool Opened

A new oil pool has been opened in Northwestern Young County, in West Texas by Mid-Continent Petroleum Corporation and Panhandle Producing and Refining Company. Their No. 1 Leverman, on a 50-min test, showed natural gas, and filled 2400 ft with oil in 40 min from 4845-54 ft.

Dakota Sand Production Discovered in Wyoming

Phillips Petroleum Company has discovered Dakota sand oil production in the Glenrock area of Wyoming. Phillips made the Dakota strike at its No. 1 Brubaker, one-fourth mile southeast of the Steelco Drilling Company discovered Dakota sand oil production 115 bbl of oil in 29 hr through a one-half inch choke. The Steelco well is producing from the Muddy sand, and Phillips attempted production in that sand, but failed to find any oil. The Dakota strike was considered more important, however, because this is the primary producing formation in other fields on the southwest side of the Powder River basin.

Skelly Uncovers Gas Zone For the Logansport Area

Skelly Oil Company has opened a new gas zone for the Logansport area of De Soto Parish, Louisiana. It is Skelly's No. 1 Fonville. The new zone is the Paluxy, which was perforated from 2991 to 3022, 3044, to 3054, and 3065 to 3076 ft. Present producing zones at Logansport are the Pettit and Jeter. The Fonville test is shut in waiting for state potential.

Republic to Establish New Producing Zone

Republic Natural Gas Company is attempting to establish a new producing zone, Sprayberry sand, in the north part of the Benedum field, Upton County, Texas. The well is the No. 1-B Rosa Barnett, which was drilled to 12,133 and temporarily abandoned last year after prolonged testing. Hole has been plugged back to 7740 and operators now are cleaning out. Republic is attempting completion in the Sprayberry at 7300-35 ft.

New Producing Area Is Opened in Jefferson Parish

The California Company opened a new oil producing area in Jefferson Parish, Louisiana, with the completion of its No. 17 Fleming Plantation. Flowing at the rate of 251 bbl of 37.1 gravity oil, the test was made through 9/64-in. choke. Perforations were placed at 8452-62 ft. The well showed a tubing pressure of 1375 lb with a gas-oil ratio of 813 to 1.

Bridwell Opens Sand Pool In Wichita County, Texas

Bridwell Oil Company has opened a new Canyon sand pool in Wichita County, Texas, with completion of its No. 1 Roller Estate. The discovery well pumped 40 bbl of 44 gravity oil daily, with production from 2948 to 2951 ft.

Condensed from an eye-witness account:—"Last winter J. W. Sherman attempted to spring-hole a well down, by hand-power, on the west side of Oil Creek Valley. His wife's money and his own strength were soon exhausted, so he traded a 1/16th interest in the well for "Pete" — an old white horse. "Pete" took the well down another 100 feet and gave up. Another 1/16th was traded to William Avery and J. E. Steele for a small engine and boiler. However, coal used to fire the boiler was "spot cash only," so, still another 1/16th was traded for $80.00 and a shotgun. Finally, on St. Patrick's Day, 1862, just as the last dollar was spent, the tools touched the "third sand." The well blew in at 2000 bbls. per day and produced for five years—with oil selling at $13.00 per barrel. The man who invested $80.00 and a rusty shotgun earned $100,000.00. The man who owned "Pete" earned $100,000.00, while the same amount was earned by the two men with the second-hand engine. As for J. W. Sherman, the man without cash or credit for a load of coal—his take was over a million dollars!"

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Frank M. Brooks has been elected president of the Kansas Geological Society for 1950. Director of the El Dorado Refining Company and manager of the geological land, and production departments, Brooks succeeds **Don W. Payne** of Sinclair Oil and Gas Company.

Brooks' assistants will be: **Joseph R. Clair,** Great Lakes Carbon Corporation, v. p.; **Ralph Ruwwe,** Stanolind Oil and Gas, secretary-treasurer; and **Don Allen,** Westgate-Greenland Oil Company, director.

Stuart Mossom has been appointed Magnolia Petroleum Company's coordinator of off-shore operations in the Gulf of Mexico. Mossom's functions will be those of a staff capacity and he will represent the company in its relationship with Continental Oil Company and Newmont Oil Company, co-owners of some of the company's properties off the coast of Louisiana and Texas. **Gerald L. Smith** has been transferred to the Dallas office as Petroleum Engineer from Magnolia's Falfurrias producing district.

Ralph A. McGoey recently resigned form Union Oil Company of California after 20 years service. He was division superintendent, San Joaquin Valley at the time of his resignation. McGoey is entering consulting business in engineering and geology.

Cecil A. Hamman resigned as division engineer for The Pure Oil Company at Olney, Illinois and has joined S. C. Yingling, Independent, at Evansville, Indiana.

After graduating from Purdue and

Cecil A. Hamman

Tulsa Universities with mechanical and petroleum degrees respectively, Hamman was employed as a petroleum engineer in Oklahoma and Texas for nine years by The Ohio Oil Company. He then joined The Pure Oil Company in Texas.

G. Frick Poe, division superintendent of production in the Houston, Texas, division, has been appointed general superintendent of the production department The Ohio Oil Company. He succeeds **Fred E. Smith,** recently named assistant manager of the company's production department. Poe began his career with The Ohio Oil Company in 1923 as a roustabout at Rock River, Wyoming. He moved to Houston in 1948 as superintendent of the Houston division.

O. V. Henry, Casper, Wyoming, division superintendent, succeeds Poe as Houston division superintendent. He was first employed in 1919 in the pipe line department at Stoy, Illinois. He was appointed division superintendent of production at Grand Rapids, Michigan, in 1943, and was made Casper division superintendent in 1948.

M. J. "Mike" Boyce, district superintendent of the Montana and Northern Wyoming district, is promoted to Casper division superintendent. Boyce joined Ohio Oil at Robinson, Illinois in 1914. During the next 30 years, he was given increasingly responsible assignments in many fields in Wyoming, Nebraska, and New Mexico. He was appointed distri t superintendent at Big Horn Basin, Wyoming in 1943.

R. W. McCanne, Casper division geologist, is transferred to Findlay as assistant to the manager of production. He was first employed by Ohio in the Red Desert area of Wyoming during the summer of 1928 while a student at the University of Colorado. Following his graduation in 1929, he rejoined the company as an assistant geologist.

He worked as a geologist in the Rocky Mountain region and was appointed Casper division geologist in 1945.

R. E. Knipe, Terre Haute, Indiana, division geologist, was appointed Casper division geologist. Knipe joined The Ohio Oil Company in the Marshall division in 1929 after re eiving a Masters' degree in geology at the University of Illinois. He was appointed Terre Haute division geologist in 1948.

C. W. Donnelly, geologist in the Terre Haute division, has been named division geologist of the Terre Haute division. A graduate of the University of Iowa with a Master's degree in geology, Donnelly began his work with Ohio in 1937 at San Angelo, Texas.

In addition to the three division offices involved in these personnel changes, Ohio Oil also maintains production division offices at Tulsa, Oklahoma; Shreveport, Louisiana; and Los Angeles, California.

K. H. Shaffer has been appointed assistant general manager of the producing department by Standard Oil Company of California. In his new position he will direct oil field devel-

K. H. Shaffer

opment work for the company. First employed by Standard in 1929, Shaffer has worked in South America and California on engineering and organization problems relating to exploration and crude oil production.

For the last two years Shaffer has been manager of producing in Standard's northern district, with headquarters at Taft, California.

Other personnel changes in Standard's producing department include the appointment of **C. W. Gibbs** as manager of the company's northern district, and **F. A. Heitmeyer** as general superintendent of producing in that area.

S. F. Bowlby, vice president, Shell Oil Company, has been elected to serve as president of the Petroleum Production Pioneers for 1950. Elected with Bowlby was **Glen Merkley** of the National Supply Company, who will serve as vice president. The new treasurer will be **L. L. Aubert,** president of Bankline Oil Company, and re-elected for another year was **Dick Sneddon,** secretary, and **Joe Rob'nson,** president of Santa Fe Drilling Company, sergeant-at-arms; **Ted Sutter,** vice president of the Baker Oil Tools, Inc., historian.

Honorary officers elected were **R. E. Stearns,** vice president of Universal Consolidated Oil Company, honorary president; **Max App,** vice president of General Petroleum Corporation, honorary vice president.

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running tour

Clarence L. Moody of Shreveport, Louisiana, has been elected 34th president of the American Association of Petroleum Geologists. Other officers for the 1950-51 term, elected by a mailed ballot of the world-wide Association membership, include **John Emery Adams,** Midland, Texas, as vice president; **Henry N. Toler,** Jackson, Mississippi, re-elected secretary-treasurer, and **Alfred H. Bell,** Urbana, Illinois, re-elected editor of the AAPG monthly bulletin. The officers-elect will assume their Association duties at the close of the 35th annual meeting, to be held this year in Chicago, April 24-27. Retiring officers are AAPG president **C. W. Tomlinson,** Ardmore, Oklahoma, independent geologist and oil producer, and **Theodore A. Link,** consulting geologist of Toronto, Ontario, and Calgary, Alberta, Canada.

Moody, a veteran of 32 years of continuous service with the Ohio Oil Company, is division geologist for his company, at Shreveport, Louisiana. In 1918, he began work in the geological department of Ohio Oil.

Adams, of Midland, Texas, newly elected vice president, is both geologist and paleontologist. During the past 13 years, however, his position with the Standard Oil Company of Texas has been that of geologist.

The new secretary-treasurer of the Association, Toler, is manager of the geological and land department of the Southern Natural Gas Company, Jackson, which he joined in 1936.

Re-elected to another term as Association editor, Bell is widely known for his contributions to petroleum geology. Since 1930 he has been head of the Illinois State Geological Survey's oil and gas division.

Howard A. McDonald was killed recently in an automobile accident near Wasco, California. A gradute of Stanford University, he was formerly employed with Shell Oil Company in South America. He has recently been an independent oil producer.

Cloyd R. Wallace has been promoted as assistant division manager of the geophysical division, producing department, The Texas Company. Wallace is in the Houston office.

He is a graduate of the University of Missouri and holds the BA and MA degrees. He was an instructor in geology at Texas A&M College from September, 1930, until June, 1933. He began with The Texas Company at Houston as an assistant computer in the geophysical division in 1934.

C. E. Riddell has recently been assigned as manager of Brazilian and Chilean operations of United Geophysical Company, Inc. with headquarters in Rio de Janeiro. He has replaced **Lawrence K. Morris,** who is returning for an assignment in United's main office in Pasadena after 6 years in South America.

C. C. Lister, manager of foreign operations, United Geophysical Company, Inc., has just returned from a trip to South America, which included an inspection of United's operations in Venezuela and Brazil.

Ezequiel Ordonez, 83, former Mexican geologist died recently at his home in Mexico City. Termed the "dean" of Mexican geologists, Ordonez discovered the first petroleum deposits in Mexico, and was a consultant in the charting of many of the world's great oil fields.

R. C. Stoner, vice president and director of Standard Oil Company of California, has retired after more than 36 years of service.

Stoner's career with Standard was chiefly in the field of geology and oil field production. He was graduated from the University of California where in addition to being an outstanding baseball player, he majored in geology, graduating with a BS degree in 1912.

In 1913 Stoner joined Standard of California in the geological division of the producing department. From then until 1917, he worked as a geologist. After two years in the Rocky Mountain area as a geologist, he went to Mexico in 1921 to take charge of exploration activities. He remained there as manager of Mexican activities, until his return to San Francisco in 1924. He was named a vice president on January 21, 1941.

Honored guests and speakers at Los Angeles Nomads regular meeting. Guests seated: M. Sawatari, N. Yakamato, T. Oinomikado, all of Imperial Oil Company of Japan. Speakers standing, left to right, Jay Gould, Anglo-Iranian Oil; E. C. Brown, Brown Drilling; "Beans" Riordan, National League Umpire (ret); Charles Blanchet, Richmond Exploration. Not pictured, Earl Rees, Patterson-Ballagh division.

At a recent Los Angeles Nomads meeting (left to right), Earle Boggess, Baker Oil Tools, Inc., inducts new members Joe Schlarb, Chiksan Company; D. M. Bernt, Pacific Perforating; D. J. Bergeron, Baash-Ross Tool; Onos Lindsay, and Gordon Jackson, both of Eastman Oil Well Survey Company.

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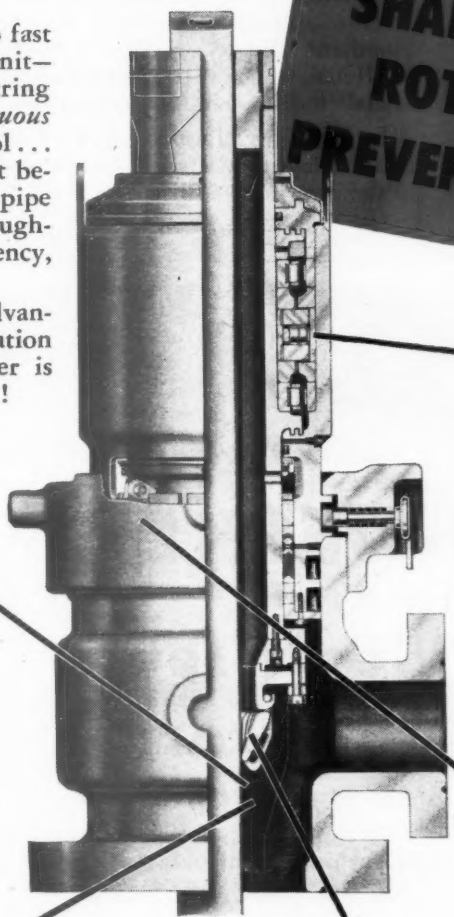

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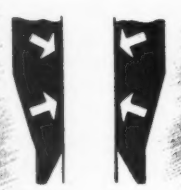

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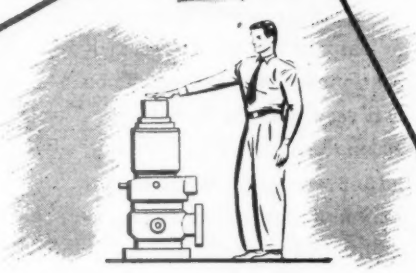

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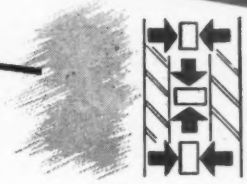

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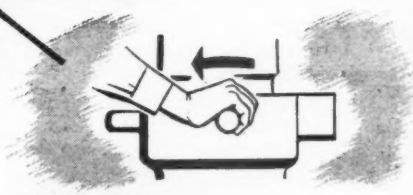

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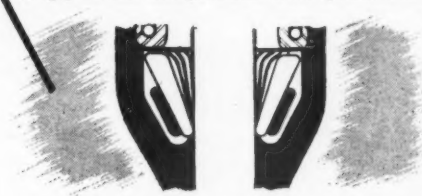

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▸ **J. T. Lee,** district civil engineer, Kelsey district, Humble Oil and Refining Company, Southwest Texas division, was recently transferred to the Tyler, Texas division office as senior civil engineer.

W. A. Schaefer was transferred to Hawkins as district civil engineer. He was replaced by **Fred S. Godbold,** who formerly was district civil engineer at the Opelousas gas plant construction district.

D. W. Marston was transferred from Hawkins to the Tyler division office as senior civil engineer.

Jim H. Kinsey, compressor plant foreman, Lovell Lake repressuring plant, was transferred to Clear Lake gasoline plant for work as gas plant superintendent.

Changes among Louisiana division supervisory personnel include: **Homer Harris,** district superintendent, Darrow district, transferred to the Sunniland district, replacing **S. E. Wallette,** who was transferred to the Mallalieu district in Mississippi.

L. H. Riley, formerly district superintendent at Mallalieu, transferred to the Avery Island dstrict.

He replaced **John B. Payne,** who was transferred to the Lovell Lake district, Gulf Coast division.

Shiles D. McCarty and **W. D. Clift,** district petroleum engineers, were transferred to the New Orleans division office as senior petroleum engineers. **J. E. Graham,** district petroleum engineer, Grand Isle district also transferred to New Orleans as senior petroleum engineer.

A. H. Townsend, farm boss at Grand Isle, was transferred to Eucutta, replacing J. M. Nesmith, who was sent to Mallalieu. Nesmith was replaced by **R. R. Alworth,** formerly farm boss at Grand Isle.

Toolpusher **W. H. Arnold** was transferred from the Grand Isle district to the Paradis district. **C. L. Sparkman,** toolpusher, transferred from Grand Isle to Eucutta.

▸ **W. H. Strang,** formerly executive secretary, petroleum branch of the AIME, has joined the staff of the division of production, American Petroleum Institute in Dallas, Texas, as assistant director in charge of engineering and district activities. Strang was active in organizing and directing similar work with the AIME for four years. He attended Colorado School of Mines and University of Oklahoma, graduating from the latter in 1938.

W. H. Strang

▸ **James C. Craig,** Continental Oil Company's superintendent of off-shore drilling operations, and **John H. Davis,** district geologist for the company's Gulf Coast Marine district, have been assigned to represent Continental in the company's joint operations with Magnolia Petroleum Company off the coast of Louisiana.

Davis, until recently geologist for Continental at Lafayette, Louisiana, was promoted district geologist of the newly-formed Gulf Coast Marine district, with headquarters in Morgan City. He joined Continental as a geologist at Lafayette in February, 1948.

Craig was appointed superintendent of Continental's off-shore drilling operations in the latter part of 1948.

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PART 1—FUNDAMENTALS OF COST ESTIMATION

How to Estimate Plant Construction Costs

GEORGE E. BROOKS

ANY attempt to present a series of articles on estimating construction costs is almost comparable to describing a system for beating the horses to a friend. It may work successfully for the author but that doesn't imply it will for the friend. All that can be said for writing such a series is that not enough of this type of information has been published. Equipment cost data are available from a variety of sources, but not often in a form that installed costs can be quickly determined. It seldom includes necessary accessories or auxilliaries such as starters for electric motors, lubricators for pumps and machinery, cooling water systems or fuel supply facilities without which the equipment is useless. In the few cases where installation costs are included, no mention is usually made as to whether or not they include overhead costs, foundations, contracting expenses, housing, utilities, etc. If these items are mentioned as included, it would be helpfull to know if they are for an isolated installation, or are the result of proration on a large project.

In this short series on estimating plant costs a system that has proved satisfactory for the author's purpose in estimating construction costs in the petroleum industry will be described. It may not prove to be applicable to estimating for the process or chemical industries in general, but it is hoped that by describing it the reader may be stimulated to adapt some of the steps to his own use and thereby profit.

There are many ways of arriving at an estimated cost for a proposed plant addition or the erection of a new plant in the chemical or petroleum industry. The quickest, of course, is the outright guess. This method, although crude, is sometimes of surprising accuracy. It is not recommended, however, as it is usually the result of a snap judgment on on the part of the estimator who probably has been called on the telephone and is staring out the window or at a blank wall trying to visualize the project being described to him by the caller. If the estimator is experienced in the field of quick estimating and has had recent cause to estimate more carefully a similar project along the lines of the one in question, he may come up with a fair enough "guesstimate." Nevertheless, it is still only an opinion and therefore subject to question.

The Author

With 14 years' experience in the design and the determination and estimation of costs of refining and other industrial plant units, George E. Brooks is well qualified to discuss the best methods for carrying on such work.

Brooks is at present employed by one of the largest oil companies to aid in directing its design and estimating division, covering all types of structures built by the company. Previously he had seven years' experience in different refineries getting at first-hand knowledge of the multifarious requirements in this phase of industrial operations. He has also had experience in the industrial electric power field, which makes him well acquainted with power requirements.

Brooks' collegiate training was received at Worcester Polytechnic Institute, in Massachusetts, receiving a BS with Distinction in Civil Engineering from that school. He was elected to Sigma XI, national honorary scientific fraternity, is a member of Phi Sigma Kappa, and is a registered professional engineer.

The next best method is the so-called *Preliminary Estimate.* Flow diagrams and a plot plan should be available on which to base the estimate, but many times these have not yet been developed and only a typewritten scope of work outlining the project and possibly a list of the major equipment required are furnished. The estimate derived from such meager information, however, can be accurate enough to give management an idea of the order of magnitude of the expenditure involved.

When the time comes to approve an appropriation for the work the preliminary estimate should be expanded in more detail. This third type of estimate I will call the *Check Estimate.* In articles to follow the preliminary estimate and the check estimate will be described in detail.

Before continuing, another type of estimate should be mentioned to complete the list of types of estimates. This fourth type is the *Detailed Estimate* as prepared by firms soliciting work under contract and who must submit competitive bids in order to win the desired contract work. These firms have the advantage of a special engineering division devoted to cost analysis of previous jobs, and have access to data concerning labor trends, price fluctuations, and all the myriad factors entering into a quoted price. This series of articles is not intended to cover that type of estimating but is directed more to the production chemist or plant engineer in the small or medium sized plant whose cause to estimate occurs only infrequently, and whose object is to determine investment costs with the expenditure of a minimum of time and effort.

The remainder of this article will be devoted to outlining the fundamentals of estimating in general, leaving the elaboration on these fundamentals for later articles. It is realized that some of the illustrations used later on may not fit exactly in any other field but that indicated, nevertheless, the explanation may furnish clues as to how the reader can develop methods suitable to his own particular needs. According to the dictionary definition, to estimate is to "compute the cost or value of anything." In this discussion the estimate of cost could be more aptly described as the most probable cost or value of anything within the limits of accuracy desired by the estimator. As the preparation of an estimate of too great accuracy can become a tedious and time consuming endeavor, it is important that the reason for making the estimate be clearly understood by the estimator before the task is undertaken. This discussion covers the methods of estimating when the object of the estimate is to determine the ap-

EXCLUSIVE

Estimating Plant Costs

As refining and other industrial manufacturing plants become more complex in design and construction, and as costs of installation rise strongly, the problem of estimating these costs becomes more important.

The presentation herewith of Part 1 of the series on How to Estimate Plant Construction Costs by George E. Brooks is a definite step forward in making available to readers of The Petroleum Engineer detailed knowledge of the methods employed. The subject is subdivided for convenience as follows;

Part 1—Fundamentals of Cost Estimation.

Part 2—The Preliminary Estimate.

Part 3—The Check Estimate.

This three-part series is the most up-to-date discussion of this subject available in any industrial engineering and operating journal. Successive installments of this series will appear in early issues of this magazine.

—Editor.

propriation required to carry out a planned expansion or modernization program. Detailed plans and specifications are usually not available and a rough cost estimate is often required to obtain approval of the project as a whole before funds are set aside for the engineering studies and design work. This first rough estimate is of necessity an approximate one but should be of sufficient accuracy and scope that a clear picture is presented of the order of magnitude of the expenditure involved. It should be complete enough to form a skeleton on which a later, more complete estimate can be built to forecast the probable cost of the project when the time comes to set aside funds for the actual construction work.

The first estimate mentioned in the paragraph above will be recognized as the preliminary estimate and the second estimate as the check estimate. Often a third estimate is made after contracts have been let, orders placed, and field work scheduled, or possibly in progress. This third estimate, which I will touch on only briefly to show the refinement required in its preparation, is beyond the scope of this discussion. It approaches the type of estimate described as being required for a contractor to make a competitive bid. It requires much time and a careful review of all orders with respect to the estimated cost of the material covered by the orders. It requires careful analysis of all contracts to be sure just what items of labor are called for and what has still to be contracted. It requires judgment in adjusting the cost of items not yet fixed to be more in line with the general trend of costs as revealed by the data compiled from work already settled upon. In short, it is an adjustment of the check estimate to be sure sufficient funds have been allotted to cover the project.

Before tackling the preliminary or rough estimate of cost, certain fundamental tools must be at hand. The first of these is *knowledge*. The estimator must have knowledge concerning the process or method of manufacture to be employed in the project whose cost he is attempting to predict. A flow diagram usually is all that is available when making the first estimate and the estimator must call on his knowledge of this, or a similar process with which he is familiar, to supply the many items entering into the cost of the unit that are not shown on the flow diagram. Pumphouses, control rooms, paving, drainage, utilities, structural supports, foundations, roads, lights, and fire protection are only a few of the items that come readily to mind. Even though not shown in the fundamental process flow they contribute suprisingly to the final cost. Knowledge of climatic conditions at the proposed site of the new work will dictate in many cases the type of construction to be employed and the extent to which winter protection or heat dissipation must be provided. Knowledge of available trained personnel in foreign jobs, and in some areas of this country is also important in deciding to what extent automatic control should be provided. The reader will probably think of several other items of knowledge that should be available to an estimator in his own particular industry. The above illustrations are intended only to indicate the background required in the field to be estimated.

Next the estimator should have some knowledge of how the process is to be operated. He should know whether or not it is a batch or continuous operation; whether or not standby equipment is necessary; what loss would be incurred by reason of failure of some item of equipment or process line or control. He should have knowledge of the alloys required to meet corrosion conditions that may be encountered or conditions of unusual stress or temperature. He should have knowledge of how the process is started and stopped to provide for the extra lines and equipment required for these essential operations.

Leaving the flow diagram now, we will look at the preliminary plot plan. The estimator should have knowledge of construction methods and technique. He should know what construction equipment will be needed and what type of foundations must be used to meet the local soil conditions. He should have knowledge as to which general contractors specialize in the type of work he is contemplating. He should have knowledge of their availability and construction methods.

Even with all the knowledge outlined above, the estimator is handicapped if he has had no experience in the field during a construction program of the size and type being estimated. Experience in the operation of a unit of the type concerned is also of great value. It goes without saying, of course, that previous estimating experience is the most valuable tool in the category of experience.

The third tool, without which the others are of little use, is access to cost data over some reasonable period of time. This information may be available in the estimator's own files or readily obtainable from outside contacts. Another source not quite as dependable, however, is current literature. This type of cost data should be used with caution unless adequate background is supplied as to the derivation of the costs shown and the conditions under which the work was performed.

A handy form for keeping abreast

DESCRIPTION	Bbls. Capacity	Type	Size	Order	Vendor	No. of Tanks	Wt. Tons ea.	MATERIAL	LABOR	DATE
Gasoline Tanks	181,000	Welded	168'x46'	NY-6666	Jones	6	650	$90,000 ea.	Erected	12-47

Tower Packing	ϕ x L	t	#/cu. ft.	Vendor	#/cu.ft.	
Carbon Raschig	1x1	1/8"	27	USS	6.50	3-49
Porcelain Raschig	1x1	3/16"	56	USS	4.20	3-49

Pumps	Size	Type	Cap.	Vendor	Order		
Light Oil	6x4x6	Dup.	26gpm	Dean	NY-1121	375 ea.	12-48
Light Oil	4x25/8x5	Dup.	10gpm	Dean	NY-1121	275 ea.	12-48

Clearing Site	Unit	Low Bid	High Bid	No. of Bids	Ave. Bid	
Clearing & Grubbing	Acre	$100	$500	18	$195	5-46
Class I Excavating	c.y.	.19	.55	25	.349	3-47
Stripping Paving	s.y.	1.30	2.00	2	1.65	2-48

FIG. 1. Cost data form in use.*

*This is a combined example of various uses for a very flexible form. It is 11 in. wide with 30 horizontal lines and 8½ in. deep with 11 columns across, as shown at top.

of costs in your own industry, which the author has developed for his own use, is illustrated in Fig. 1. The sheets are standard letter size (8½ in. x 11 in.) punched with three holes for insertion in a binder or loose-leaf note book. The note book has the usual alphabetical index and costs can be entered at any convenient time being careful to note the date in the column to the far right. The seven columns shown to the right of the column headed "Description" are purposely left blank in the printed form. They are then available for listing whatever pertinent data is required to identify properly the item whose cost is entered so that later costs may be correlated, as will be discussed later. The four lines at the top of the form are for identifying the class of items listed on that page of the book. The sample form shown in Fig. 1 has been partially filled out for several different classes of items merely to show its flexibility. It will be noted that in some cases the material and labor columns are not used at all, as in the case of "clearing the site" where equipment rentals and other factors are included in the recorded price. The majority of costs kept on this form are base costs exclusive of contract costs and other charges that are added customarily at the end of an estimate on a percentage basis. The same form is also used with the long dimension in the vertical direction, but then only four unheaded columns are available between "Description" and "Material." This arrangement is useful when a number of items of one class are being accumulated but only a minimum of information on each item is necessary to identify it properly.

The three tools, knowledge, experience, and cost data, mentioned as prerequisite to estimating are more or less of a special nature for each field of manufacture or processing and little can be gained by discussing them further. It is assumed that the production chemist or plant engineer has all three. The fourth tool, *system* or *method* is not of such special nature and therefore is of more general interest to would-be estimators.

The first step in a good system or method of estimating is to have some means of correlating the available cost data. The majority of items involved for which cost records are kept can be plotted on cross-section paper using cost versus size, capacity, weight, horsepower, or some other common variable. An interesting point to remember in this connection is the fact that many items seem to follow an exponential type curve that, when plotted on logarithmic paper, shows up as a straight line. In other words, cost equals a constant times capacity or size raised to a fractional power. (Y equals Ax^b). The constant A must be determined for the given item and will vary from year to year with price fluctuations. The exponent b, however, does not seem to be subject to the variations found in A and for all practical purposes in so far as the type of estimating under discussion is concerned can be assumed to remain constant. When no other information is available an assumed value of 0.6 will be found to be very reliable for b.

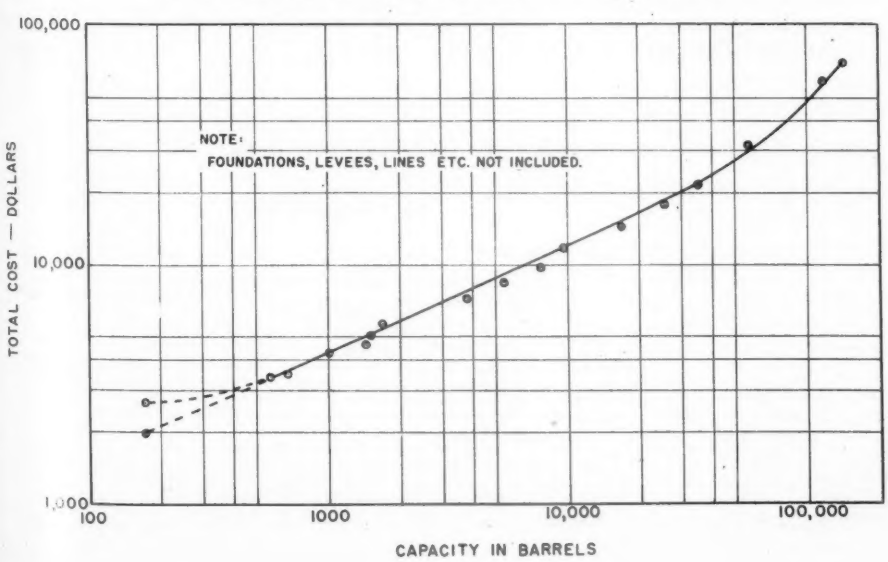
An example of data correlated according to the above principle is illustrated in the accompanying Fig. 2 where a chart is shown on atmospheric tankage erected in an oil refinery in 1948. The curve represents actual erected costs for all-welded tanks exclusive of foundations, levees, pipe lines etc. The items excluded materially effect the installed cost of the tankage but are independently variable according to local conditions and therefore omitted from this discussion. They can be evaluated independently according to the same method as the tanks proper from their respective cost records. By separating them from the tanks proper the cost of tankage employing a different type of foundation can be derived from one set of curves for tanks and several curves for the different foundations involved.

It will be noted from the curve that between the limits of 1000 bbl and 35,000 bbl a straight line follows the plotted points very closely. This fits the exponential theory discussed previously. Above 35,000 bbl, however, the curve rises more sharply and the exponential theory no longer holds. It is by carefully correlating data that these special cases are revealed and corrected for. Below 600 bbl two dotted tails are shown for the curve to indicate the unreliability of data in this small capacity group and to indicate a probable range of costs that may be expected.

From the slope of the straight line portion of the curve the exponent b can be determined as 0.44. With this exponent known, it can be used to find the most probable 1949 cost of this series of tanks if a 1949 cost is known for one of the tanks falling in the straight line section of the curve. The 1949 cost is plotted and a new curve drawn parallel to the old curve. This method is very handy for quickly estimating today's costs from data that is outdated. Care must be taken, however, in selecting the 1949 basing point to be sure it is typical of the group of tanks being estimated. One point is a rather slim thread from which to deduce costs of tanks varying very much from the known tank. The more data that can be kept up to date the more reliable will be the results. The illustration merely serves to bring out the point that correlation of data is of prime importance to good estimating. Later on this principle will be applied to entire operating units in the discussion on preparing the Preliminary Estimate.

Typical of the class of items that does not lend itself readily to the derivation of a smooth curve is heat exchanger tubular units. This equipment should be correlated according to several variables. If your plant has adopted a standard size and guage of tubing and restricted itself to one or two, tube lengths, the problem is

FIG. 2. All welded atmospheric tankage. Delivered and erected costs by contract or order, 1948.

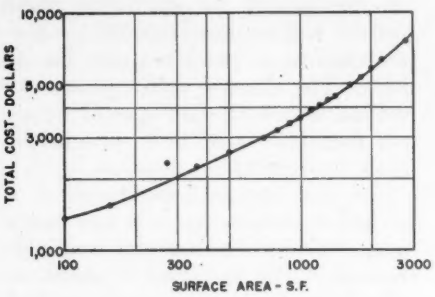


greatly simplified. A curve similar to that shown in Fig. 3 can be plotted and will be accurate enough for preliminary purposes. Note that between 700 sq ft and 2200 sq ft a straight line representing an exponent of 0.65 is extremely close to all points in that range. A more accurate curve would tend to follow the form of a series of steps. Shell diameters are usually increased in even increments according to the manufacturers' standards and a given shell may be used for two or three or more heat transfer surfaces according to the vapor space requirements or pressure drop limitations governing tube spacing and baffle arrangements. A cooler tubed to the full capacity of the shell with average pressure drop and having a surface of 1000 sq ft will cost less, understandably, than a condenser of the same area but requiring a large vapor space and wide tube spacing for low pressure drop, especially in the higher pressure ranges.

The next fundamental tool in estimating is some outline or general form to be followed in the preparation of all estimates. If the form chosen is sufficiently elastic to encompass all types of projects falling in the estimator's field, it will serve as a handy reference file when preparing cost estimates for new jobs. It will prove of special value when used in conjunction with the cost recording system to be discussed later. A form for cost estimating, which the author has found to be quite satisfactory, is shown in Fig. 4 partly filled out to illustrate its use and advantages. The left-hand section is of standard letter size (8½-in. by 11-in.) and punched with three holes for assembling in a binder or loose-leaf notebook. The right-hand page is slightly more narrow so that when it is folded back out of the way it does not lap over the punched holes.

The various items making up the project are listed to the left in the

FIG. 3. Cost of tubular units, January, 1949. Carbon steel tubes ¾ in. by 16 ft long, 1 in. square pitch, 150-lb design.



usual manner followed by the number or quantity required and the unit cost applicable. Next the material cost for the item is entered by multiplying quantity by unit cost. Further to the right is the man-hour column. From the man-hours needed and the labor rate for the craft involved the unit labor cost is obtained and multiplied by the number of items or quantity required to get the labor cost to go with the material cost already entered. In the example illustrated total man-hours was used times the labor rate to get the labor cost.

At some future date when the estimate is referred to as a guide in the preparation of a new estimate some particular material cost or labor cost may appear to be out of line with what might have been expected. At the time of preparing the original estimate any derivation of unit costs should be made on the right hand page of the form where it will always be readily available to explain the apparent discrepancy. Other jobs referred to in making the estimate should be noted on this page and any quotations obtained or order prices used should be listed so that they can be verified. Sketches required to help calculate quantities should be made on this sheet also and not on scraps of paper to be thrown away or lost. In some cases the right hand section of the form will become filled far ahead of the left hand section, but only items backed up by data on the right should be entered on the left. It is better to have several sheets that can be easily analyzed for checking or reuse than a few sheets that are worthless after serving their original purpose.

The last step in providing the tools for good estimating is one over which the estimator usually has little control. It involves some means of obtaining information as to the actual expenditures made in the field on the job he has estimated. This requires some system of cost recording. The estimator can help in this phase of the work by providing a cost outline. A cost outline is nothing more than a list of items as they appear in the final cost estimate which is furnished to the office force on the job. It is filled out at regular periods with the amount spent and committed against each item, and in an extra column the field should enter its estimate of what additional funds will be required to complete each item. With this information coming in regularly any large overexpenditure can be detected in advance and proper steps taken to provide for it. It also provides the estimator with current information as to where his estimates are out of line with actual costs. Of course this last tool will not ordinarily be available to the small organiation but if the production chemist or plant engineer is on the site during construction, the idea of cost recording is one he may wish to use personally whenever the opportunity or time presents itself. If this type of record can be accumulated it will save many headaches in the future.

Summarizing this discussion, the fundamentals of estimating have been presented as knowledge, experience, cost data, and system. With these four tools we are ready now to tackle the preliminary estimate in the next article. * *

FIG. 4. Estimate of cost form and calculation sheet 16 in. wide by 11 in. deep.

ESTIMATE OF COST

EST. NO. 6030 SHEET NO. 1 of 7
ENG'R'S. EST. ____

REPAIRS TO HEATER Nº2

PLANT NAME Lynn Works
DWG. NO'S. 3-1077→82, 6-121 & 8-38 COMPUTED BY GEB DATE June 7, 1949

	ITEM	QUANTITY	MATERIAL UNIT	MATERIAL TOTAL	LABOR M.H.	LABOR UNIT	LABOR TOTAL	TOTAL COST
	Dismantle heater			$1415	3580	¢1.92	$6875	
	New Struct. Steel	22.3T	300	6690		110/T	2450	
	New Tubes	26	312	8100	1130	x1.92	2170	
	New Fittings	26	340	8850				

CALCULATION SHEET

Refer to Job #1608
Repairs to heater #1 in Feb. 1946 ENR 153.6
Dismantling cost $950 for material; $5948 for Labor.
Proposed repairs to heater #2 requires same amount of dismantling. ENR Today 229
Todays material cost: 229/153.6 x 950 = $1415.
Labor rate on previous job - $1.66
Manhours used = 5948/1.66 = 3580 M.H. Todays rate - $1.92.

New struct. steel Required - 22.3 Tons. Refer to Drwg. G-121. For price order see CH-47925. For erection see cost curves - Technical Data Book - P.11.
New Tubes 5"x3½"x35' (5% Cr.) 26 required. Wt. 1200# @ 26/lb = $312/each.
For alloy costs see order CH-2073.
New fittings 350# each @ 62½ ¢ = $340 each. (26 req.)
Labor Installing Tubes and Fittings on Job #1608.
Cost $ 9078 for 126 tubes or $72.29/Tube. Labor rate then $1.66.
Manhours = 72.29/1.66 = 43.5 M.H./Tube. This job has 26 tubes.
Manhours required 26x43.5 M.H. @ $1.92 Labor Rate.

THE TECHNICAL FORUM

The right answer points out how to improve your methods to gain more efficient operation at better economic levels. The Forum Panel provides some clear answers to recent questions.

Control of Grease Melting Point

Q What factors or steps can be applied in the manufacturing procedure to control the melting point of the finished grease?—M. E. E.

A For a particular soap cation the proportion of fluxes or peptizers present will influence the melting point. What we term fluxes are materials such as free fat, fatty acids, glycerine or other alcohols, all of which tend to soften the soap at temperatures lower than that at which the pure soap would melt.

The proportion of free fat of course can be reduced by more complete saponification, thus raising the melting point. Fatty acids will saponify so readily that they are not a problem, except in the case of aluminum soaps and with the latter neutralization is not possible.

Most grease making processes do not lend themselves to removal of glycerine. A number of years ago some manufacturers of Locomotive Journal and Rod Pin greases resorted to prolonged heating at 500 F or higher so that part of the glycerine would be volatilized. This, of course, was in fire-heated equipment, the mineral oil being cylinder stocks of high flash. It would no doubt be possible to remove some glycerine by vacuum if the mineral oil present did not volatilize.

Of course the concentration of the soap will have some effect upon the melting point, that is a lubricant with say 15 per cent of soap will melt at a little higher temperature than one with 10 per cent.

Soaps of unsaturated fatty acids will normally melt at lower temperatures than those produced from saturated fatty acids. Therefore choice of fat will influence the melting point of the finished product.—B. & M.

Lube Oil Extracts

Q What is known of the composition of lubricating oil extract from solvent extraction, and what commercial or industrial products are made therefrom?—W.R.A.

A Knowledge of the chemical character of the extracts from the selective solvent refining of lubricating oils is qualitative and depends chiefly on inference. The type of lube stock treated limits the composition of the extract. In general, the extract consists of a complex mixture of high boiling cyclic hyrocarbons of the aromatic, asphaltic, naphthenic, or asphaltic-aromatic types or a mixture of naphthenes and aromatics. The extracts have a high resin content and range from 6 to 15 API gravity. They are usually dark or black in color, which limits their application to fields where this can be tolerated. The principal uses of these extracts are in rubber compounding as softeners and extenders, in low-cost interior paints, and in plastics, particularly in polyvinyl chloride, as a resin extender and as a partial replacement for ester plasticizers. *James H. Boyd.*

Straightrun Gasoline

Q What is the future of straight run gasoline as a motor fuel component as octane ratings go ever higher and higher? Is the trend toward more or less sweetening operations?—A. R. W.

A These are really two separate questions. In reply to the first question, at present octane levels, around 80 Research number for regular grade, a straight run fraction boiling below 250-300 F can usually be economically incorporated into motor fuel directly. The 250-400 F may or may not be reformed depending on how much is available after the kerosine and fuel oil market requirements have been satisfied. With octane numbers above 90 in many cases thermal reforming of even the light C_5—250 F fraction would be necessary and for the highest octane numbers, above 95, it is likely that catalytic reforming would be practiced on this fraction.

The trend in sweetening operations is to those which effectively extract mercaptans, the odoriferous gasoline components, rather than converting them to desulfides. Such processes as unisol, mercapsol and Tannin-Solutizer will eventually displace doctor and copper treating which still leave the sulfur compounds in gasoline. Increasing octane numbers require increasing amounts of lead and the adverse effects of sulfur compounds become more pronounced at the high lead levels which are becoming necessary. *John Happel.*

Hydrocarbon Synthesis

Q What are the primary reactions involved in the so-called Fisher-Tropsch hydrocarbon synthesis, and what are the theoretical yields from 1000 SCF of methane? What yields are being obtained in pilot plants, so far as is known?—C. W. Berger.

A Although the Fischer - Tropsch synthesis has been under constant investigation since its introduction in 1923, the mechanisms in this reaction are still not settled. It is undoubtedly one of the most complicated ever to be used commercially. Starting with carbon monoxide and hydrogen the reaction is carried out over a catalyst, such as iron promoted with an alkali, to produce a mixture of the following compounds:

Synthetic hydrocarbons consisting principally of straight-chain compounds, both olefinic and paraffinic, varying from methane to solid waxes.

Alcohols such as methanol, ethanol, propanol, butanol, pentanol, and higher.

Aldehydes such as acetaldehyde, propionaldehyde, and butyraldehyde.

Ketones such as acetone, methyl-ethyl-ketone, methyl-propyl-ketone, and methyl-butyl-ketone.

Acids such as acetic, propionic, butyric and higher.

In the discussion following his presentation of a paper on the development of this process[1], Dr. H. H. Storch of the U. S. Bureau of Mines discussed the possible mechanism very briefly. His belief was that formaldehyde might be the first compound formed at the surface of the catalyst. Reduction by the hydrogen present would lead to the formation of the methylene group and the initiation of a very complex series of reactions involving the addition of hydrogen and carbon monoxide and subsequent reductions and dehydrations.

With this in mind it can be seen that there is no really "theoretical" yield, as carbon monoxide may find its way into either a very simple molecule such as butylene or, on the other hand, it can go into the formation of a wax of a greater than 2000 molecular weight. The distribution of the products is affected by:

a. Temperature.
b. Pressure.
c. Feed composition.
d. Catalyst characteristics.
e. Space velocity in the reactor.

According to Latta and Walker[2], of Stanolind Oil and Gas Company, the following operation could be expected on the basis of their pilot plant data:

Feed: Oxygen, 95 per cent purity, 56,000,000 SCFD.

Natural gas, containing 22 per cent N_2 but nothing heavier than propane, 109,000,000 SCFD.

Production:

Gasoline	4,800 bbl per day
Heavy oils	1,200 bbl per day
Oxygenated hydrocarbon chemicals	420,000 lb per day.

Some of the chemicals that would be produced are not now available in commercial quantities.

References:

1. Storch, H. H., Chem. Eng. Progress 44, p. 469-80 (June 1948).
2. Latta, J. E. and Walker, S. W., Chem. Eng. Progress 44, p. 173-76, (February 1948).

C. F. Sanderson and A. S. Glendening.

Protective Coatings

Q (1) Are storage and shipment containers for aviation fuels lined with protective coatings nowadays?—L. R. N.

A No. The only protection is scrupulous cleaning, and, wherever possible, use of aviation containers exclusively or aviation products. The chief headache, where the latter is not possible, is contamination with products having relatively high gum or residue contents, which in turn make it difficult to meet the very rigid aviation specification restrictions on these points. —*Anon.*

Q (2) If liners are required, are they to protect the fuel from container materials, or to protect the container from fuel attack?—L. R. N.

A See (1). If suitable liners were available and in use, they would be for the protection of the fuel from oxidation, such as arising from contact with rust or scale on the container walls, and from contamination with rust or scale particles. —*Anon.*

Q (3) What contamination, if any, of the fuel results from storage or transport in unlined vessels? Is aviation fuel more susceptible in this manner, or are its containers more subject to attack than those for other spark ignition engine fuels?—L. R. N.

A Where proper precautions are taken to clean the containers, the remaining sources of difficulty as influenced by the containers themselves are contamination with rust or scale particles and somewhat accelerated oxidation of the fuel as a result of such particles acting as another source of oxygen (in addition to the oxygen dissolved in the fuel or introduced during any "breathing" of the container). Such accelerated oxidation may in some cases result in failure to pass specification requirements on gum and residue, and may involve some degree of lead precipitation. Another problem reported occasionally but not frequently by some producers involves a complicated reaction which may result in a color change of the fuel. This appears to involve a reaction of the ethylene dibromide tetraethyl lead "scavenger" with the oxidation inhibitor. Occasionally there may be a "fading" of the dyes added to distinguish between fuel grades.

Where the container is not properly cleaned, the chief contamination problem is as in (1), along with the oxidation effects mentioned.

Aviation fuel is not more susceptible to the above problems than other fuels. On the contrary, because of its rigid specification limits on stability it might be regarded as less susceptible. The main difference is that in the case of aviation fuel, considerably less latitude is allowed by specification for contamination. The final product must be "purer," which means that even slight oxidation or contamination may be intolerable.

The above picture may change in the next few years as a result of the introduction of new tetraethyl lead scavengers currently under development. These may allow use of linings or galvanizing hitherto considered undesirable because of reactions of the presently-used ethylene dibromide with such materials. The chief benefit of such linings, as you can probably gather by now, would be in prevention of rusting and scaling, and thus reduction of the tendency of the fuel toward oxidation. —*Anon.*

How to Get Technical Advice

In the Technical Forum the refining or gas processing man puts his question to the unrivaled Forum Panel,* composed of a group of nationally renowned authorities. You get the right answer here at no cost to yourself and virtual limitless possibilities for improvement in your operations.

Address your query to: **Technical Forum Editor, *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas,** and the specialist or specialists in the subject of your problem will tell you what you want to know within a short time.

**See The Petroleum Engineer for October and for December, 1949 for pictures and biographies of Forum Panel members.*

SPARKS IN THE PLANT

DON ATTAWAY*

MAN first produced fire from sparks. Whether those sparks were generated by friction or by impact between hard substances is not known. The primitive method of rotating a stick rapidly against kindling material was used in the early ages and in some sections of the world, natives produced fire from flint and tinder. In many uncivilized sections of the world today, fire is produced with amazing speed from these early and crude methods alone.

Of course, progress and modern industry has found numerous ways to produce fire and to regulate and control it for the service of mankind as a useful servant, but sparks have no place in a modern industrial plant.

Uncontrolled fire is a fearful master and in spite of our precautions and constant warnings, fire takes a yearly toll in America of over $700,000,000 and 11,000 lives. A large percentage of these fires originate from sparks.

In a 7-year survey conducted by Associated Factory Mutual Fire Insurance Companies covering 19,485 industrial fires, the causes were determined in 93 per cent of the fires. Sparks produced by static, combustion, friction, or electricity accounted for 41 per cent of these fires.

Sparks are a very potential source of ignition and are actually used in many instances to ignite flammable materials or mixtures. Consider the gasoline engine and the common cigarette lighter as examples.

Before any fire can be produced, a certain series of conditions must be present. These conditions vary under different circumstances but basically, three elements must be present in order to produce a fire. First, we must have a fuel or a product in vapor form that will burn. Secondly, we must have oxygen. The fuel and the oxygen must then be mixed in the proper percentage depending upon the limits of inflammability of the fuel. Finally, we must have a source of ignition or heat in sufficient amount and degree to kindle the mixture. A spark will meet this requirement.

When these three conditions exist, a fire will result every time. SOURCE: Sparks are produced in numerous ways and the following sources are present in almost every refinery and industrial plant. The most common methods are:

1. Friction or impact
2. Welding
3. Electric
4. Smoke stacks
5. Engine exhaust
6. Smoking
7. Pump packing

The control of these sparks at each and every source is the first step in fire prevention.

Friction or Impact Sparks

Sparks produced by the force of impact or by tearing them from the main body of the metal are heated by the force of the impact or striking and consist of small particles with a low heat content. The danger of such sparks therefore is limited even though they may often have temperatures of 2000 F or higher. They cool quickly and start fires only under the most favorable conditions, such as falling in loose dry cotton, combustible dust or vapor, or explosive materials. Large particles of metal, which could retain their heat longer are not heated usually to dangerous temperatures.

The real danger of such sparks depends to a large degree upon the character of the metal. The greatest hazard being particles of metal that readily oxidize and burn as in the case of iron or steel. Soft metals, which do not readily oxidize, and from which particles may be torn without sufficient energy to heat them to a high temperature, do not create a serious hazard, but low intensity sparks may be produced even from brass. Nickel, monel, and bronze are examples of metals that have only a slight spark hazard. Stainless steel is much less dangerous than ordinary tool steel.

Special tools of copper-beryllium and other alloys are designed to minimize the danger of sparks in hazardous locations but cannot wholly eliminate it because even then a spark may be produced under certain conditions. This is often true where such tools are used on heavily rusted metal, in the presence of vapors with low ignition temperatures, or struck against cerium, flint, or some soft spark producing metal or stone. For this reason such tools should not be called "spark-proof". Safety authorities refer to this equipment as "spark-resistant."

Smoking a cigarette was the alleged source of ignition in this fire. A spark from either match or cigarette ignited vapors during unloading operations.

Leather-faced, plastic, and wooden tools are free from this hazard and as an additional safeguard in highly hazardous locations, such as explosive manufacturing plants, special soft-surfaced floor coverings and mats are used to avoid the creation of sparks from dropped metal objects on concrete floors.

The ignition of flammable vapors and gases by friction or impact sparks is sometimes over-emphasized. Consideration must first be given to the ignition temperature. Hydrocarbons with low initial boiling points ordinarily have low ignition temperatures. Kerosine, naphtha, and solvent are not readily ignited by metal sparks. Nevertheless, it is best to avoid the use of grinding wheels and other sources of mechanical sparks in areas where flammable liquids, gases or vapor may be present.

Welding Sparks

According to a reputable insurance company, welding and cutting operations caused more than 7000 fires during the past three years. In 1943 fire losses resulting from welding opera-

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EXCLUSIVE

tions reached a peak of $13,000,000.00. Just how much of this was due to sparks and not actual flame contact is not known.

The fact remains, however, that fire is the most serious hazard connected with welding operations. Heat sufficient to start fires comes from the flame itself; from the metals being welded or cut; metal that blows and drips from the cut; and, most serious of all, from the sparks that fly from the work.

Oily waste, rags, burlap, excelsior, cartons, straw, and paper burn vigorously once started. Wooden flooring, wood chips, and lumber are less likely to catch fire than the others mentioned, but even these require special precautions for fires started in them are likely to smolder at first and flare up some time later, due to a possible gust of air or natural draft created by the smoldering heat.

Pieces of iron heated to a bright red may retain enough heat to start fires for 15 seconds or even longer under some conditions. Although metal may be at a black heat in daylight, it can scorch wood or paper so that a fire may start if there is enough draft.

Because welding sparks often fly in so many directions at once and sometimes travel a considerable distance, they must be watched closest of all to make sure they do not start a fire. These sparks are really little balls of glowing metal oxides and are produced heaviest during cutting operations. It is not unusual for such sparks to travel 25 or 30 ft away from the point of cutting. It goes without saying that if sparks should fall into an open container holding a flammable liquid, a quick, dangerous fire would result. Serious engine pit fires have resulted from such a cause when the pit was oil soaked.

Every foreman or supervisor in charge of welding or cutting work should know that when this work is part of plant regular or repair operation and is carried on in the same location time after time, there is small likelihood of starting fires. This is because fire hazards are eliminated usually before welding equipment is installed. Any hazards in welding shops, sheds, or permanent welding quarters are usually corrected and the work safeguarded before work starts.

On the other hand, such work done with portable equipment at various points in the plant is hazardous unless precautions are taken. The first rule, of course, is to never use a torch where an open flame would be dangerous.

If the area is suitable for an open flame, and the foreman or supervisor has authorized the work, care should be taken that flammable materials are not near. Such material should be moved to a safe location or shielded by asbestos curtains, metal guards, or similar protection. If possible, the area should be wet down.

It might be well to bear in mind that welders often use friction lighters that produce sparks and caution should be exercised in entering suspicious gas or vapor areas where an accidental bump may cause a spark.

Sparks from the exhaust and muffler of a tank truck can cause fires such as this when flammable vapors are present from spills or leaks.

Electrical Sparks

According to the National Fire Protection Association, more than 52,000 fires were started last year from electrical causes. The number resulting from sparks is not known. It is conceded, however, that frayed or worn insulations, overloaded circuits, bridged fuses, and unapproved or defective appliances produced most of these fires and sparks can be produced by any of them.

Even the throwing of an electrical switch can cause a spark. This arcing at switches is a source of ignition. Such a spark in the presence of a flammable gas or vapor mixture has been the cause of numerous fires and explosions.

The ordinary electric motor is a generous sparks producer, especially when brushes are worn or out of order.

All electrical equipment in hazardous locations should be installed according to the code for such areas. Explosion proof switches and motors are imperative.

It must be borne in mind that devices operated by either wet or dry cell batteries also produce sparks. Flashlights, ignition systems, telephones, and alarms are frequently found in refineries and gasoline plants. As a safety precaution such devices should be explosion - proof. Some installations are called "vapor-proof" but there is a doubt that all equipment can be made entirely free from vapors.

Static electricity is not to be confused with stray currents or the commonly generated electric current. Static is a type of electrical charge resulting from the contact and separation of two substances, one or both of which are non-conductors. Such a charge can be produced by liquids pumped through lines or hoses. High voltages may accumulate at terminals or nozzles.

A common and generous producer of static electriciy is the drive-belt.

Autos and trucks also produce intense charges of static ranging as high as 16,000 volts. The contact and separation of the tire tread on the road surface as well as the movement of the metal body through the air generates this electricity.

The difference in potentials determines to a large degree whether or not static sparks can be created. Relatively high potentials (300 volts or over) may produce sparks that will ignite certain combustible material. Humidity also plays an important part, as static sparks are more severe in dry cold weather than during humid warm

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The 11′ x 139′ Deisobutanizer Column pictured above is a sample of the Sun-built refinery and chemical plant equipment that has made the name Sun Ship as famous on land as the Sun-built tankers and cargo ships that ply the seven seas.

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weather. This is explained by the fact that during winter months indoor equipment becomes dry from artificial heat and low humidity, but in summer when humidity is high most surfaces become coated with a film of moisture that acts as a conductor and permits the static to dissipate as it is generated.

The generation of static is difficult, if not often impossible, to prevent. Charges of low potential are very common but fortunately not always dangerous. They do not cause trouble because the sparks are not sufficiently hot to ignite flammable material.

Tests on a Wimshurst machine have revealed that a potential of 5000 volts will ignite a gasoline vapor-air mixture.

The prevention of static sparks depends upon equalizing potential charges. For moving belts and shafting, the charge is not always eliminated by grounding the pulley. The belt itself must be grounded. This can be done by placing grounded metallic combs or sweeps close to, but not touching, the surface of the belt. The points of the comb should be sharp like a needle. In atmospheres where ether or highly explosive vapors are present, the comb cannot be used. Such a condition calls for conductive belting and pulleys. Common metallic shafting can be safeguarded by grounding the bearing and the shaft separately.

Storage tanks and loading racks should be bonded and grounded. In loading tank cars or trucks, bonding wires should be used between the piping and the vehicle. Static generation is highest during loading and unloading operations and positive bonding and grounding is necessary to prevent sparks.

It is a well established fact that truck drag chains have little or no value in the prevention of static sparks and are often in themselves a hazard.

Smoke Stack Sparks

Boiler installations require stacks and thereby develop a source of sparks. Of course, the degree of hazard depends largely on the fuel. Where wood is used for fuel, sparks from the boiler stacks frequently cause fire. Such stacks should be equipped with spark arresters, or else spark chambers or deflectors built into the base of the stack.

Refinery operations, however, generally use gas or oil as boiler fuel and sparks are not a serious hazard. It is possible, however, for such installations to produce sparks. Heavy deposits of soot, carbon, and scale in fire boxes and stacks accumulate unless cleaned out and often glowing carbon is released to the atmosphere. Such a spark landing upon flammable material can easily cause a fire. Ordinarily, plant lay-out places the boiler house at a safe distance from flammable product storage, but grass and weed fires have resulted from boiler stack sparks that spread and damaged the plant.

Welding sparks travel a considerable distance and on pipe line work such as this numerous fires are started in dead grass, weeds, and leaves.

Engine Exhaust Sparks

In plants where combustion engines are operated, the exhaust remains a source of sparks that is difficult to control. As a safe practice such exhausts are usually installed and directed so that back fires will not endanger personnel or property. Most installations contain muffles and relief vents in case of internal explosion that affords some protection.

Muffler sparks are frequently produced even though the engine uses gas or oil for fuel, however. For the most part, they are small bits of glowing carbon, although at times sections of scale saturated with oil and soot are ignited and expelled with much force and to a considerable distance by engine backfire.

Smoking Sparks

Although smoking is generally prohibited in industrial plants and especially at refineries and gasoline plants, there are usually areas in which employees are permitted to smoke and the rule is often violated where supervision is not strict. The smoking habit with its associated handling of matches is the greatest fire cause. Each year some 87,000 fires are traced to carelessly discarded cigarettes, tobacco ashes, lighted matches, and smoking in hazardous locations.

Pipes and cigarettes are generous producers of sparks sufficiently hot to ignite flammable materials. The careless knocking of ashes from pipe bowls often deposits heaps of glowing coals and sparks upon material such as dry grass, leaves, and weeds that easily ignite. Sparks from the paper or tobacco coals of discarded cigarettes are entirely capable of igniting vapors and many flammable materials.

It is imperative that no smoking be permitted in plant operating areas and in locations where conditions are such that controlled smoking can be permitted, it is a safe practice to provide adequate ash-trays, sand buckets, or containers of water for discarded cigar and cigarette butts as well as pipe ashes and match stems.

Pump Packing Sparks

In the past five years, safety authorities have uncovered a new source of sparks in refinery and gasoline plant operations. From reports and observations of fires involving pumps handling very volatile hydrocarbons, a conclusion has been reached that aluminum foil packing was the source of ignition.

The actual spark is created by the very rapid oxidation to incandescence upon exposure to air of a small flake of clearly polished aluminum foil. As long as the foil is submerged in fluid and excluded from air, no spark can be produced. As a result, ignition usually takes place where the pump is out of service or being repacked.

This hazard is usually found in high speed centrifugal pumps and certain safe practices should be followed in repacking pumps that are fitted with aluminum foil rings. The fluid should be removed from the pump by flushing with water before repair work is started.

Conclusion

This article cannot, of course, cover every phase and possibility of sparks in detail, but the major sources listed are the most important and control of these spark sources in any industrial plant is the solution to the most part of fire prevention.

Generally speaking, plant fires have small beginnings and are easily extinguished or prevented. It is the neglected hazard, the careless act, the forgotten spark, and the unknown danger that contributes to the loss of a plant by fire.

Precaution and safety engineering are the keys to plant safety. It pays big dividends. ***

NATURAL GAS

Extraction of Dust and Mist

J. A. CAMPBELL*

THIRTY-TWO years ago, when the writer first started in the oil industry, there was a crying need for a separator to take crude oil mist from the natural gas entering the compressor plants where the natural gasoline was extracted by means of compression and refrigeration. It was not realized so much at that time, but had we had a good mist extractor on the outlets from our accumulators, a much higher percentage of the gasoline content of the gas would have been recovered. Possibly this would have delayed the development of the absorption process. When we first began building absorption plants, the crude mist proved a great source of trouble. Field gas traps never were noted for any high degree of efficiency in effecting a separation of the oil from the gas and the crude oil would go through our compressors, gumming up the valves and then it would contaminate our absorption oil, lower its absorption ability, increase its viscosity and deposit in our heat exchangers and preheaters.

The author did a great deal of experimenting in the early days on various types of tangential separators and then with baffle designs. After designing the most baffling baffles it was often found that when a mixture of gas and oil passed through, they proved to be just exceptionally good atomizers. About this time, huge wells were coming in at Huntington Beach, Santa Fe Springs and Long Beach. A company was formed and we began constructing gasoline plants. It was realized then that a separator must be designed to clean the gas before taking it into the plant. In desperation, a glass model was built. From this model it was learned quickly that what was considered to be one of the most difficult tasks of a baffle design was really the easiest. That function is the agglomeration of the mist particles into a film. Interpose practically any surface to the mist laden gas flow, say a shingle, and immediately agglomeration is obtained. The real problem is to get the film off the shingle and not let it pass back into the gas stream.

At the time a flat baffle with its edges turned back 135 deg was in use. It worked very well when water was applied because water has a high surface tension. When kerosine dyed a deep purple was passed through this design, white paper held in the effluent gas was colored instantly, not only stained but dyed a deep purple. The gas passed into the catch pockets and whipped the agglomerated film off in a sheet and it got by all the rows of baffles in a similar manner. It was obvious that if this action was to be stopped, a surface must be designed for the baffles that woud prevent the creeping of the film to the edge of the baffle.

Time was passing. A contract had just been signed for a large plant at Santa Fe Springs. Wet gas blowing in the field was showering the surrounding country with crude oil and it was vital that a suitable design be worked out quickly. The idea presented itself of running longitudinal beads in baffles and then riveting screen wire to the beads. The theory was that the screen would be very effective in agglomerating the particles of mist. It had been noted that an ordinary flyscreen does this beautifully in a fog so that practically every interstice is bridged with a water film. It was assumed that the film as it built up on the screen would be driven through and would trickle down on the back side of the screen in the space between the screen and the metal baffle entirely out of the flow of the gas. The importance of isolating this oil and removing it from contact with the flow of gas was realized, so dams were built across the rows of baffles and seal tubes were run from between the dams through the bottom of the baffle box and were sealed below the float-controlled liquid outlet in the bottom of the vessel. (See Fig. 1.)

This design was built quickly and put into the glass container. It worked to perfection. It could be run for a week with white satin ribbons placed in the outlet gas, and even though the kerosine was dyed such a dark color and was blasted into the baffle nest in such quantities that you could not even see through the glass between the first two rows of baffles, not the slightest stain showed on the white ribbons.

The first big Mist-D-Fier, as it was decided to call the equipment, was immediately designed and built and put into the plant that was being built. This required fast work because in those days orders were taken for gasoline absorption plants over the phone and work started the next day. The plants were completed in from 31 to 35 days (before planned economy). Working was not considered an old-fashioned idea. There was a fine friendly spirit between employee and employer and the men took great pride in their workmanship. Inventories were not prohibitively taxed and material was readily available. A contractor, if he were smart, could give a firm contract and hit his cost estimate within one per cent. He could get a nice legitimate profit, which he was very happy to split with his men.

This first commercial Mist-D-Fier kept the oil in the plant a beautiful clear amber color and threw out 125 bbl of crude oil per day for which the owners received $1.25 per barrel.

Feeling that we were entitled to a patent, we applied for one. Against our claims was cited an old British patent issued many years before, and the examiner refused to allow any of our claims. In the meantime hundreds of Mist-D-Fiers were being sold and installed. Several unscrupulous manufacturers were copying the design. An appeal board reversed the examiner's decision, allowed every claim and censured the examiner for not allowing the patent on original claims. This in effect was a basic patent and is still in force. The name Mist-D-Fier was copyrighted and became nationally known.

The life of the screen was a cause for concern. Eventually it would rust out and even though copper were used, it would be attacked by sulphur compounds. In certain cases stainless steel was used but the cost was so high as to be almost prohibitive.

The gas companies had been using the screen design, but about three years ago when they started an inten-

*Research and Development Engineer.

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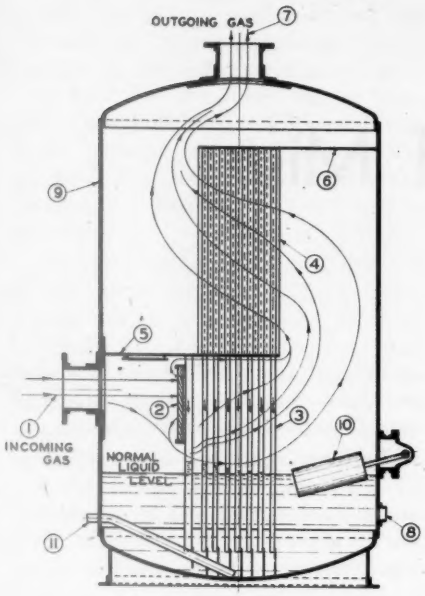

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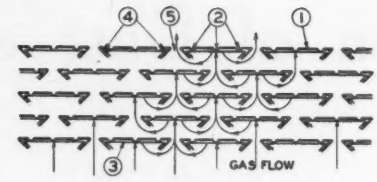
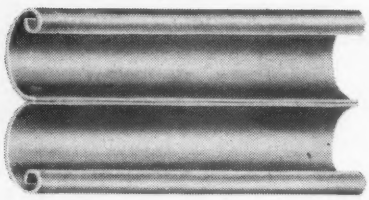


HORIZONTAL SEC. OF BAFFLE NEST SCREEN TYPE



A DOUBLE BAFFLE SCREENLESS

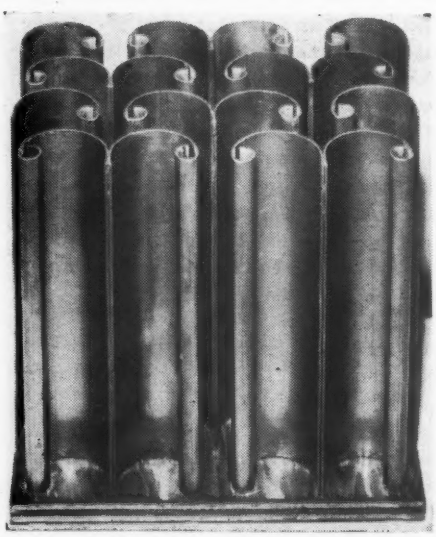
FIG. 1. Vertical section through Mist-D-Fier. Horizontal section through first five rows screen type—One double baffle, screenless type, showing how metal is rolled.

sive campaign of treating the gas with diethylene glycol, they were operating under high pressure and wanted to put an element in the bottom of the contactor and one in the top and then stress-relieve the whole assembly. This, of course, would make ash out of the screens. Their engineers stated they must have a baffle design without screens. In spite of seven years' fruitless effort to solve these problems previously a solution was hit upon, late one night. Plans were submitted, and a steel model was made that worked perfectly.

Many baffle designs with surfaces curved into about every conceivable shape and having catch pockets for trapping the oil have been made. The difficulty has been that the gas flow gets into these pockets and whips the oil off their edges. The secret lies in carrying the curvature at the pocket to such a degree that any drip from the lip goes into an almost completely closed pocket. The baffle is made in two halves, spot welded together. It is similar to two sections of guttering with their raw edges secured together but with their rolls turned in instead of out. The small roll on each edge is rolled in so completely that its edge almost meets the surface of the large roll. This leaves a slot that is ample to admit the moving oil film but that is entirely too narrow to pass gas in and out at the same time. These two rolls on each baffle, in effect, create vertical conductor tubes. Their upper ends are sealed off. These double baffles are spaced in rows and alternate rows are staggered so that the long narrow stream of gas hits the sharp edge in the middle of each double baffle and divides. The impact is tangential and the stream is curved in conformity to the curvature of the baffle. The mist particles, which are of greater density than the gas, shoot ahead and impinge on the curved surface of the baffle and agglomerate into a film. The gas drive forces this film along the curved surface into the slot where it runs down the side of the small roll to a level well below the top of the dams that run transversely across the bottom of each row of baffles. Between these dams the seal tubes conduct the oil into the storage space in the bottom of the vessel. The gas flow follows the curvature of the baffle in general until it comes to the roll. It lifts over the roll and hits the stream from the adjoining baffle, flows through the slot between the two baffles, and is again split by the sharp edge of the double baffle, which is directly back of this slot and in the next row. Gas will not enter the narrow oil slot because it would have to come out of the same narrow slot into which it went, such being impossible. Even though this should be possible, it would have to buck the velocity head of the gas drive toward the slot and the oil drive into the slot.

This velocity head undoubtedly compresses the gas in the slot tubes to a slightly higher pressure than outside the tubes. Therefore, since flow is always from a higher to a lower pressure, if there is any flow at all in the tubes it is downward and aids in moving the oil film down the walls of the slot tube. Such gas as may flow in this manner must make a full 180 deg upward turn to clear the dams and get back into the main stream. The streamlined tangential impact on the curved surface is so much more effective that the number of baffles can be reduced to 9 rows instead of 11 as used with the screen-faced type. It is inevitable that liquids spatter from impact against a flat surface and this spatter is picked up in the flow. Impact on flat surfaces also creates eddies that produce turbulence resulting in a higher pressure drop through the baffle nest. The new design has materially improved the capacity.

FIG. 2. Photo showing staggered arrangement of baffles, in rows.



PATENTED

Dust Removal

Dust has presented a tough problem in the transmission of gas over great distances. Gas often contains finely divided, dried-out drilling mud, and even geological formation material. The alternate wetting and drying action of the inside of the steel pipe causes the formation and flaking off of iron oxide, which is carried by the gas in all grades and sizes from chunks to almost colloidal size. This extraneous material is hard on compressors and it is vitally important that this dust be scrubbed out ahead of the compressor suction. Oil is usually employed as a scrubbing medium and it is equally vital that none of this oil carries over.

Combination dust scrubbers and Mist-D-Fiers are now being built in a single unit that removes every trace of dust and mist from the gas and affords complete protection for the compressors. One of these vessels will handle 150,000,000 cu ft per day. The sound-

est design for contacting the oil with the gas is the old syphon tube. The size, length, and number of the tubes and also of the oil return tubes are matters of engineering design depending on the quantity to be handled and the pressure range.

One exclusive feature of our design is the method of baffling the syphon tubes to obtain more intimate contact with the gas and the oil. Another is in baffling the discharge from the syphons to avoid shooting the oil directly into the Mist-D-Fier element. Still another is to interrupt the turbulent effect of the oil return to keep the reservoir more or less quiescent and permit the settling of the dust mud.

One can learn more from working models than from all the drawings that can be assembled. The author has made glass or Lucite working models of practically every development in the past 20 years and they are invaluable.

The illustrations accompanying this article include both still and action pictures. Next to actually showing the model in operation, they constitute the best way of giving some idea of the remarkable preformance that goes on inside the Lucite cylinder.

Referring to the pictures:

In Fig. 1 (below, right) can be seen the way in which the heavy steel is rolled. The two halves are securely fastened together by spot-welding. The shape of the cross section results in a high radius of gyration, which makes the baffles very strong structurally.

Fig. 2 shows the arrangement of baffles in rows and the staggered arrangement so that the division in each double baffle falls directly back of the slot between two baffles in the row ahead. This assembly of only a few short baffles on a wooden base was made for photographing only but it shows the actual arrangement in the baffle nest. Note the two full baffles in the front row and the single full slot in the center between them, also the two half slots on either side. These half slots feed the half-baffles in the second row. The full slot feeds the double baffles in the center of the second row. In a four-foot shell there will be eight double baffles, seven full slots and two half slots in the odd rows, and seven full baffles, two half baffles, and eight full slots in the even rows. Thus, all rows have the same slot area for passage of the gas. This insures uniform velocity throughout and uniform pressure drop across the various rows.

Fig. 3 is a still of the model. The actual apparatus, which is a pressure vessel, has semi-elliptical heads but since the model operates at atmospheric pressure it is simpler and more convenient to use flat heads. The gas to the steel shell is admitted through a flanged nozzle located just beneath the oil plate but since it is easier to drill and tap the flat bottom Lucite plate, the air, which is blown by a vacuum cleaner, is brought in through the bottom plate and a tube that reaches to within an inch of the oil plate. This is well above the oil level even when all the oil is in the bottom of the vessel. Kerosine is used to represent the wash oil because of its low surface tension, low viscosity, and high penetrability. It forms a finer mist and is more difficult to separate from a gaseous flow than any common liquid. The apparent offset and enlargement in these pictures of the syphon tubes and oil return tubes below the oil level is due to light refraction. You will note that there are four syphon tubes and two oil return tubes. The latter are only $\frac{3}{8}$ in. longer than the former. The two syphon tubes in the middle of the picture are baffled. The other two are clear. This is done in order to show the superior action of the baffled tube that is used in the commercial jobs. The oil plate carrying the syphon tubes and the oil tubes is tightly sealed against the inside of the lucite shell.

Mounted on the four screws above the oil plate is an annular baffle to break the upward jet action from the syphon tubes and insure thorough contacting of all dust with the oil.

In the upper part of the picture are shown the edges of the vertical baffles in the nine rows. There is one full baffle in the center, two half-baffles in the odd rows, and two full baffles in the even rows. This staggers the baffles and produces a tortuous path for the gas. This arrangement provides two full-width slots for the gas passage through the odd rows and one full-width and two half-width slots in the even rows. This keeps the flow and the pressure drop uniform. There is a high dam across the bottom of each odd row of baffles and a low dam

FIG. 3. A still model of the Mist-D-Fier.

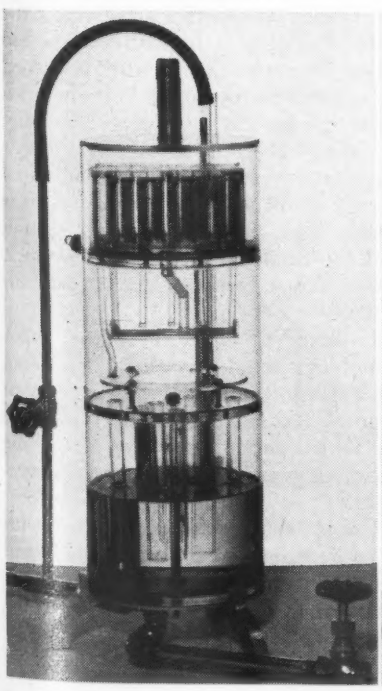


FIG. 4. An "isometric" view of the baffle box.

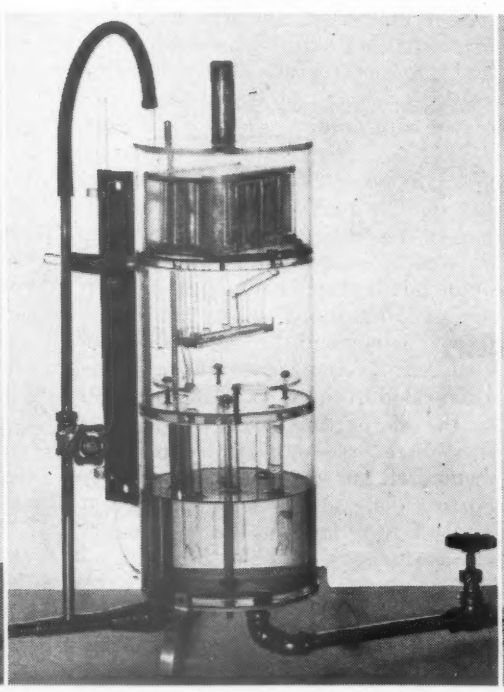
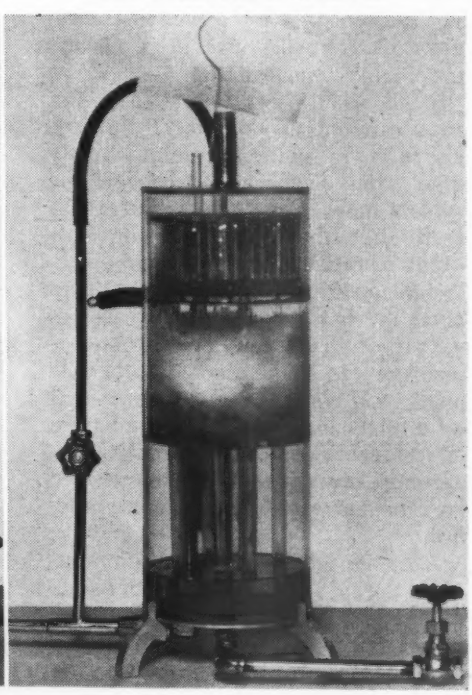


FIG. 5. Blower forcing air through model to simulate operation.



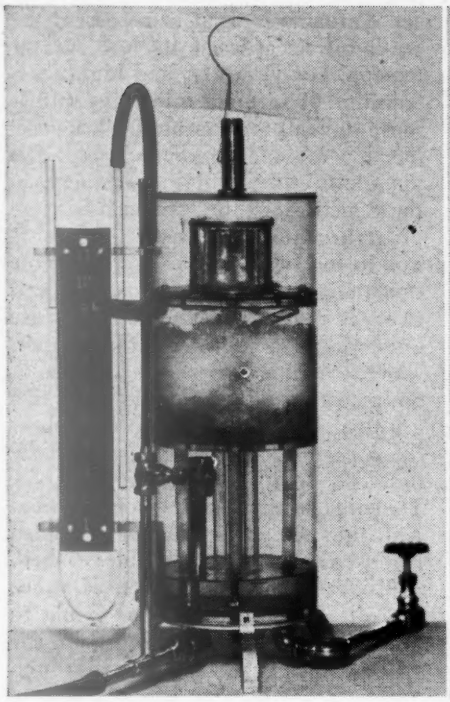


FIG. 6. Open manometer shows the pressure differential across the model.

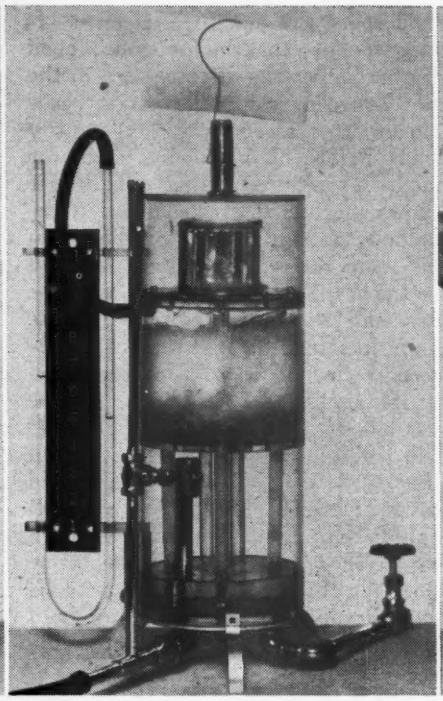


FIG. 7. In this view the open manometer is connected to the side outlet, showing a true pressure drop reading across the "baffle nest."

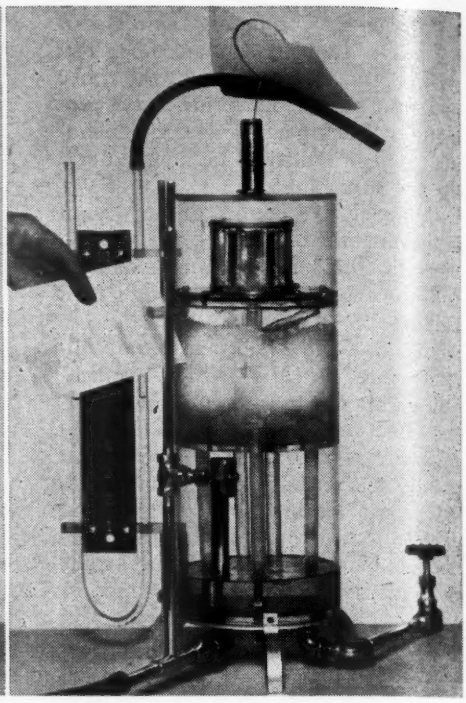


FIG. 8. Stains on white paper that has been over the outlet, show what happens when mist extractor is not connected into system; stains are oil carried out by the gas.

on each even row. The seal tubes extend through and are just flush with the bottom of the baffle box. The seal pan is made of Lucite and is cemented to the three end tubes, which are cut off at 45 deg on the bottom. There are two seal tubes in front of the first dam only. The first row of baffles throws down most of the liquid. The second row catches most of what pours through the slots of the first row.

The offset tube shown in the picture is merely for the purpose of filling the seal pan for a demonstration after its contents have been sloshed out during transportation.

Note also a bent Lucite tube that runs through the annular baffle just above the oil plate at a point directly above the discharge of one of the syphon tubes. This tube discharges directly into the full gas stream at a point where it pours through a segmental opening in the plate that supports the baffle box. This tube is not a part of the regular design and is incorporated in the model for the sole purpose of blasting large quantities of oil directly into the face of the baffles to produce a separating problem under more severe conditions than would ever be encountered in actual practice.

A Lucite tube manometer is mounted on the side of the model with a one-foot section of our standard Campbell gauge stripping. This is used to measure the total pressure drop across the entire apparatus when the rubber tubing is connected as shown in some of the action pictures.

Just below the sealing ring, to which the baffle box supporting plate is attached and gasketed, is a tube outlet, shut off with a short piece of rubber tubing and a lucite plug. When we wish to determine the exact pressure drop across the baffle nest only, we connect the rubber tubing to the manometer to this outlet.

Since no oil whatever gets into the top of the vessel, the upper head is merely a flat Lucite disc shouldered to a neat fit on the inside of the rim of the shell. A short nipple through this serves as an outlet for the gas or air.

In Fig. 4 the model is turned to give an isometric view of the baffle box and a partial view of the segmental opening through which the gaseous flow enters the baffle box. The baffle box is sealed completely on both top and bottom. The top has a segmental extension to which a thin piece of Lucite is cemented. This skirt is also sealed to the sides of the box and to the supporting plate outside the segmental opening. The box is cemented all the way around to the supporting plate so it is seen readily that all the flow of gas and liquid is forced to pass through the baffle box with no leakage, and discharges through the slots of the last row of baffles, that is located right at the open end of the box. The completely cleaned gas fills the upper portion of the shell around the baffle box and discharges through the gas outlet. But before looking at the action picture, note that the level of the oil in the base of Fig. 3 is about half way between the bottom and the oil plate.

Now the blower has been started in Fig. 5 and is blowing air through the model. When the air entered the lower chamber it immediately forced oil up the syphon tubes until it opened up enough ports in the bottom serrations to pass the gas and oil. This figure shows the model operating under the most severe conditions. The initial charge of oil was such that when it is blown into the intermediate section and thoroughly frothed by the gas it comes almost to the bottom of the baffle box.

Looking to the left of the upper chamber a large quantity of oil being blasted into the baffle box can be seen through the skirt. Yet observation of the white paper held directly in the outlet stream shows not the slightest stain.

Fig. 6 shows the manometer with one leg connected to the inlet gas and the other to atmosphere. The differential of approximately 6½ in. is the total drop across the model.

A very good end view of the baffle

The pictures for illustrating this article were taken by the Larry Reighner Studio of Long Beach, California.

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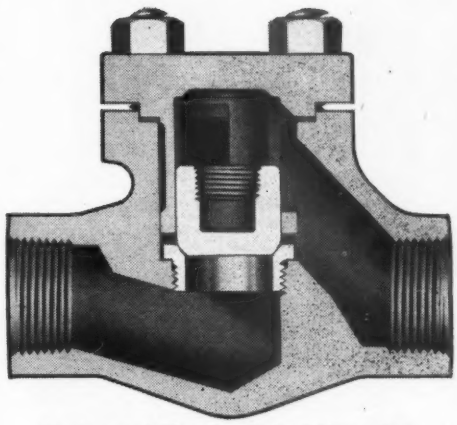

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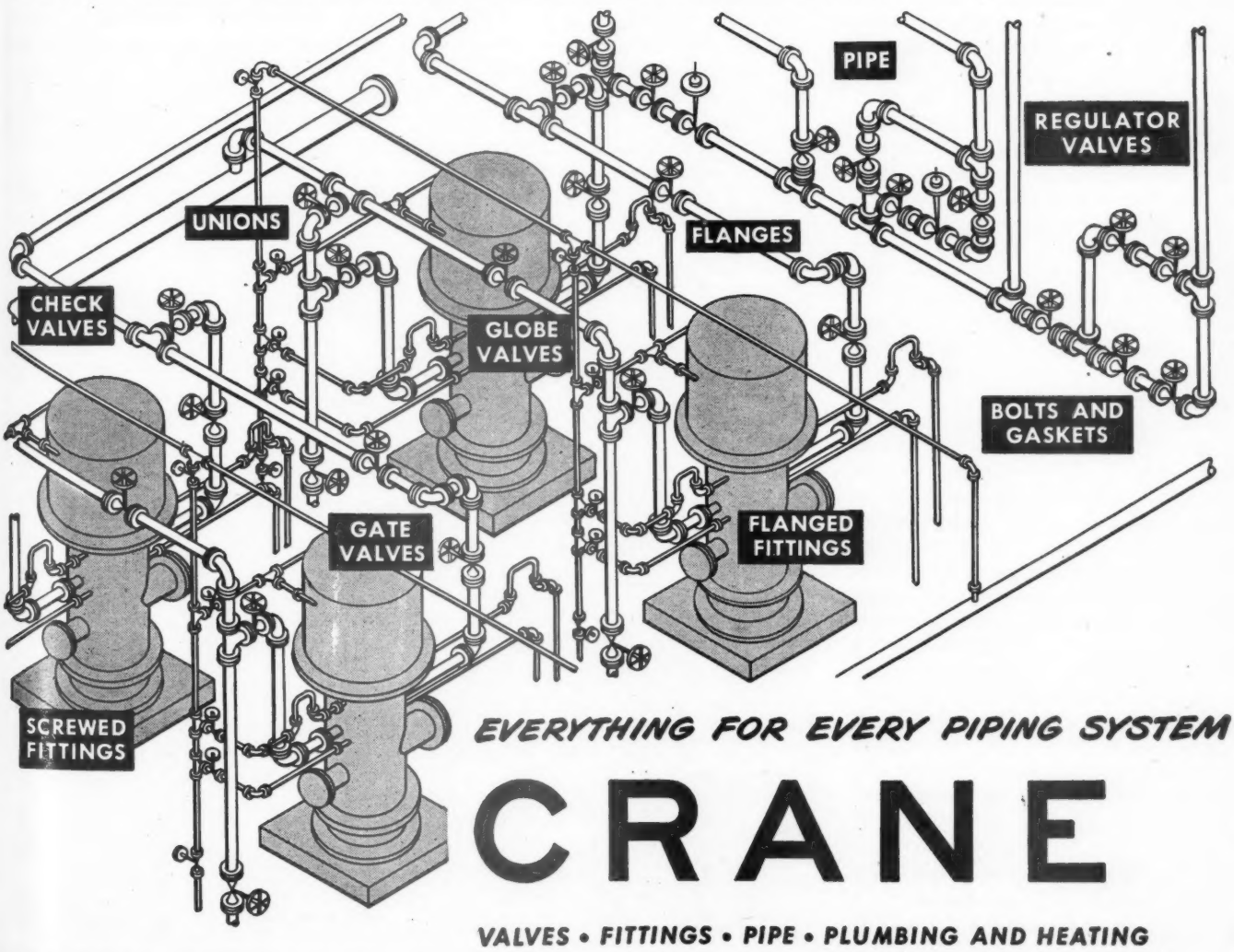

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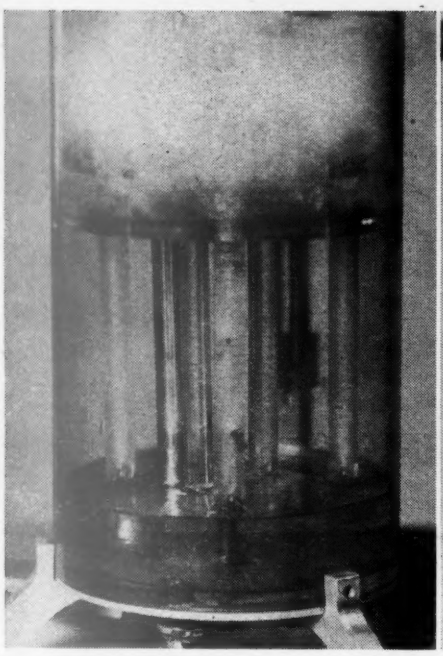


FIG. 9. Close-up of tubes, showing the better action in the baffled tube, center, as compared to unobstructed syphon tubes, right and left.

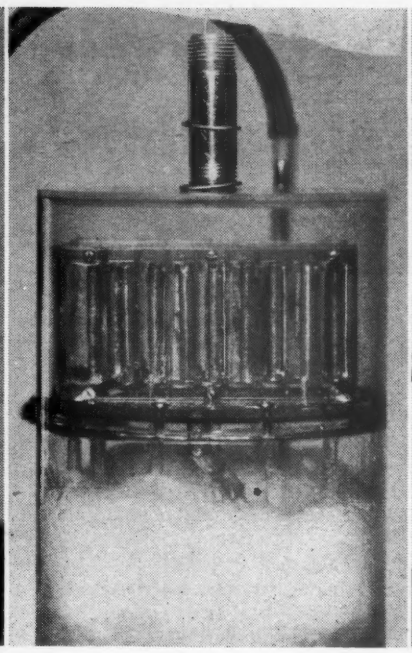


FIG. 10. View of the baffle nest, showing liquid banked against the dam of the second baffle row by the gas flow.

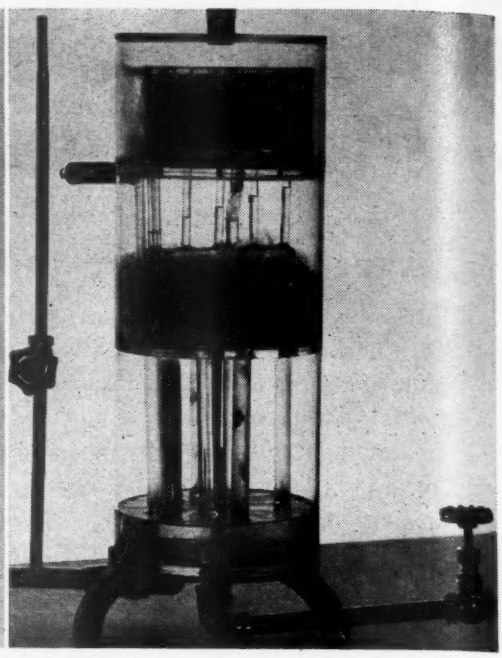


FIG. 11. View shows oil level in the (vertical) seal tubes. Oil level in each tube shows differential between it and first tube on left (middle compartment).

box shows the oil being hurled against the first row of baffles.

Fig. 7 shows the manometer tube connected to the side outlet; a true reading of the pressure drop across the baffle nest is obtained.

Fig. 8 illustrates what would happen without a Mist-D-Fier. This picture was snapped a split-second after the stopper was pulled off the tube. The stains tell the story.

The object of Fig. 9 is to show the much better action obtained in the baffled tube (center) than that by the unobstructed syphon tubes (right and left). The baffles create turbulence, which breaks up the big gas bubbles and prevents any tendency for dust particles, suspended in the gas, to blow through the oil without coming in contact with it. Observing the picture carefully evidence is seen of the large downward flow of oil rushing from the bottom of the return tubes in the bubbles of entrained gas that this flow carries. In the actual apparatus, this flow is not permitted to reach the bottom and agitate it, and thus facilitates the settling of the dust-mud.

Fig. 10 is a closeup of the baffle nest, a side view in which the liquid banked up by the flow of gas against the dam of the second baffle row can actually be observed. A heavy run-down of oil is noted in the first three seal tubes. The fourth is behind the filler tube. The fifth and the sixth are perfectly clear. The bottom of the baffle box is absolutely dry beyond the sixth row of baffles.

Before Fig. 11 was taken some of the oil was drained from the model so as to afford a much better view of the levels in the seal tubes. These tubes play a very important part in the performance of the extracter. The inlet to the baffle box is on the left side and since the two seal tubes are ahead of the front row of baffles the level shown in them above the level in the open-top seal pan is a true measure of the pressure drop through the segmental opening to the baffle box. The level in the second tube shows the drop across the first two rows and the middle tube shows the drop across the first four

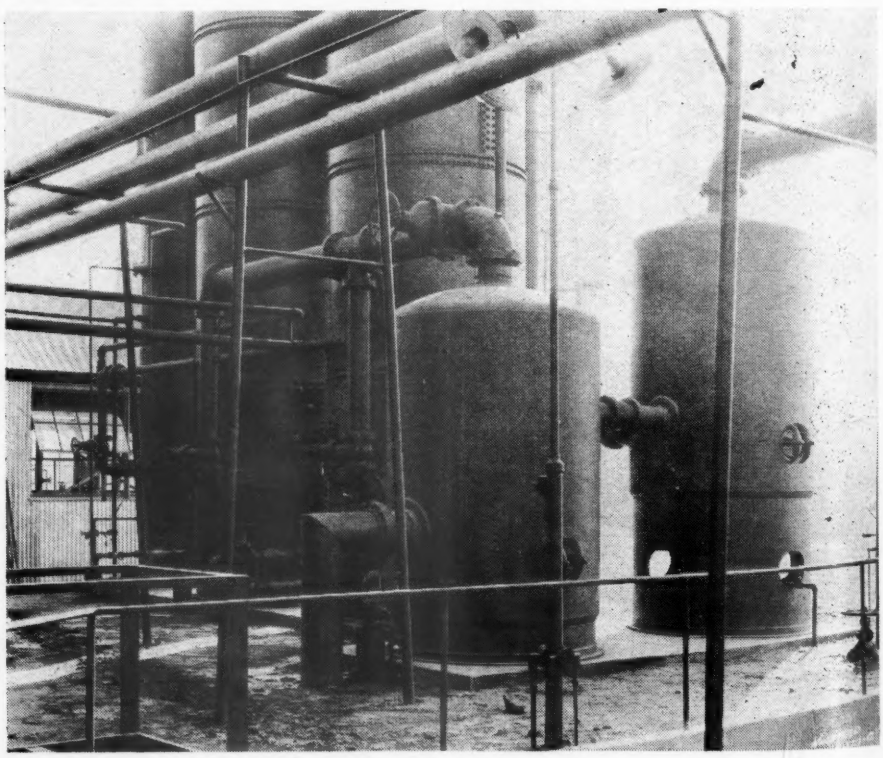


FIG. 12. Inlet and outlet Mist-D-Fiers installed in a commercial absorption plant.

rows, the next tube across the first six and the last one on the right shows the total pressure drop across the first eight of the nine baffles. These columns of oil in the seal tubes afford a true balance between the constant pressure on the surface of the oil in the seal pan and the various lower pressures between the rows of baffles. These balancing columns of oil in the tubes provide a means of permitting the oil to flow from the lower pressure of the upper section to the higher pressure of the intermediate section. The static head of the oil in the tubes is sufficient to over-balance the higher pressure below.

This arrangement isolates completely the oil from the gaseous flow and gets it out and down into the scrubbing oil. Gas cannot break through the "solid" head of oil and by-pass any of the rows of baffles.

Of course, if the oil in the intermediate chamber is allowed to build up where its surface is above the edge of the seal pan these balancing columns of oil will start and build up from this level.

In this article the difference between the surface tension of water and kerosine has been mentioned. Surface tension, simply explained, is that property of the molecules on the surface of a liquid that causes them to cling together, forming an enveloping "skin" that is sufficiently strong to hold the liquid in the drop. If the surface tension is high, a large drop will form. If the surface tension is low, a much smaller drop results. A very simple method of determining the relative surface tension of two liquids is to fill a medicine dropper with one liquid to a definite notch mark on the glass. With a steadily increasing pressure, gently squeeze the bulb, counting the drops as they leave the end of the glass tube. Next, repeat the operation with the other liquid. Of course, temperature affects surface tension, so the liquids should be at the same temperature. Repeated tests have shown an average of 27 drops of water to 54 drops of kerosine, the maximum variation between any two tests being 2 drops. Since surface tension is a measure of the ability of a liquid to cling to the baffle surface, we see why the use of kerosine affords a much more severe test of the model. Ordinary motor fuel gasoline shows 65 drops by the same test. * * *

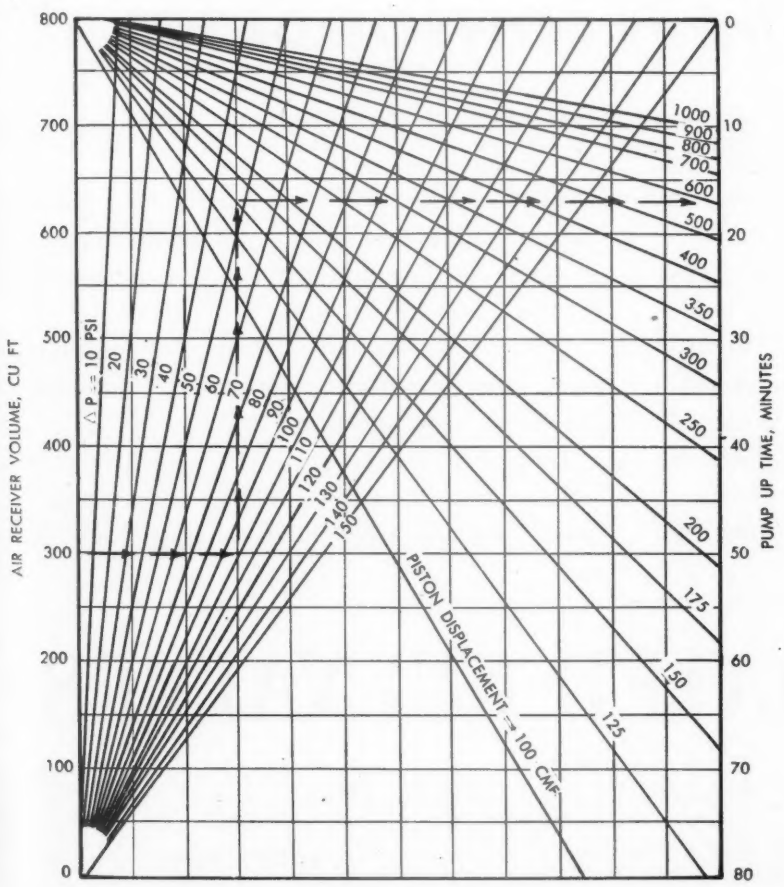
Figuring Air Receiver Pump-Up Time

By TYLER G. HICKS

REFINERIES and gas compressor stations use compressed air for many maintenance and operating jobs. An air receiver is always used in conjunction with the compressed air system. As the air compressor should not operate continuously, it is often necessary to determine how long it will take for a given compressor to raise the pressure to the proper value in a receiver. This chart provides an easy and quick means of finding pump up time for any capacity receiver.

Problem: How long will it take to pump up a 300 cu ft receiver with a compressor that has a piston displacement of 150 cu ft per minute if the "cut in" pressure is 100 psi and the "cut out" pressure 200 psi?

Solution: Enter the chart at the left with a receiver volume of 300 cu ft and project horizontally to the curve labelled $\triangle p = P - p = 200 - 100 = 100$ psi. At the intersection, project vertically to the curve marked 150 cfm piston displacement and then run across to the right and read 17 min pump up time.



The chart shown here is based on compressors placed at sea level. For other altitudes, solve the problem as shown above and divide the result by the ratio of the actual atmospheric pressure to that at sea level.

Problem: How would the pump up time vary if the compressor in the first problem was placed in a gas compressor station 1500 ft above sea level?

Solution: Atmospheric pressure at 1500 ft elevation is 13.91 psi. Hence, pump up time = 17 min/(13.91/-14.7) = 18 min. Usually, pump up time will increase with distance above sea level, other factors remaining constant.

When the compressor has a displacement greater than 1000 cfm, solve the problem using a displacement of 1000 cfm and divide the result by the ratio of the actual displacement to 1000 cfm. If $\triangle p$ is beyond the range of the chart, solve by using a $\triangle p$ value, which is one-half or one-third of the actual value and multiply the result by two or three.

The relation $$T = \frac{V(P-p)}{14.7(PD)(VE)}$$ was used in constructing this chart. Symbols are as follows:

T = pump up time, minutes; V = receiver volume, cu ft; P = final pressure in receiver, psia; p = initial pressure in receiver, psia; PD = piston displacement, cu ft per min; VE = average volumetric efficiency of the compressor, assumed here to be 80 per cent. * * *

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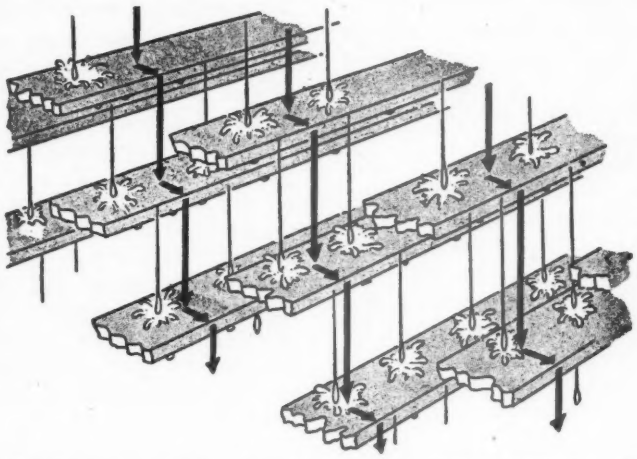


FIG. 1. Cooling tower lowers water's temperature because water drops between and on wood-filling are exposed to moving air. Slight evaporation carries away heat, thus cooling water.

Water-Cooling Towers

HOWARD E. DEGLER*

PART 1 — PRINCIPLES AND APPLICATIONS

In the operation of refinery condensing processes one of the most important problems is the dissipation of heat from the compressed petroleum products. This heat is generally removed from the "gas" by transferring it to water in a heat exchanger, from which it may then be dissipated in a number of ways. If the petroleum equipment were on the banks of a river or lake, the intake and discharge connections could be installed so as to prevent mixing of the heated discharge water with cooler inlet water.

If the source of cooling water were a well or city supply, the water might (but should not) be discharged into the sewer or open water-way. Outright waste of this heated water is usually uneconomical and frequently illegal. Lacking an inexhaustible supply of water from one of these sources, or in cases where water is too expensive or its waste prohibited, or where the water contains dissolved salts which would probably scale up the heat exchanger apparatus, it becomes necessary to re-use the water again and again after each passage (cycle) to cool it by exposure to air in an atmospheric water-cooling apparatus.

*Technical Director, The Marley Company, Inc.

Water-Cooling

Water, by having its waste-heat load transferred to the atmosphere, can be re-used in a continuous cycle and thus conserved. The transfer of heat can be effected by bringing the water and air together indirectly (non-contact) as is done with the automobile radiator, or directly as is done with evaporative-cooling equipment such as atmospheric spray ponds, cooling towers, etc.

When cooled by the evaporative effect, water transfers to the air approximately 1000 Btu (heat units) for each pound of water evaporated. The heat contained in the water vapor thus produced is known as the latent heat of vaporization. Air, absorbing heat from water in this manner, is capable of cooling the water below the atmospheric (dry-bulb) temperature. This phenomenon is of basic importance to the subject of transferring heat from water to air. This distinctive fact permits water cooled by the evaporative method to serve applications having a great variety of temperature requirements, and it also enables a small volume of water to dispose of a much greater heat load than would otherwise be possible.

Surface evaporation is what maintains cool water in the old-fashioned canvas water bag. Evaporation of perspiration helps the human body to maintain its normal 98½ F temperature, despite higher atmospheric temperatures. The heat exchange in atmospheric water-cooling equipment is accomplished partially by a transfer of sensible heat (about 25 per cent) that raises the wet-bulb temperature of the air, but most of the cooling is due to an exchange of latent heat resulting from the evaporation of a small part of the water. As the water falls from deck to deck, in a water-cooling tower, down through the wood filling (Fig. 1) it splashes into fine droplets and spreads out over the wood laths in thin films, thus providing the utmost exposure of water surface to the upward-moving air. The rate of heat transfer by convection and evaporation, hence the amount of water-cooling effect, will be accelerated by: (1) Increasing the velocity of air passing over the exposed water surface; (2) increasing the surface area of the water being exposed to the passing air; (3) lowering the atmospheric pressure (increasing elevation above sea level); (4) raising the entering water temperature; and (5) reducing the water-vapor content (humidity) of the air.

Air is the ideal medium for the cooling of water. It is available in unlimited quantities and serves not only to absorb the water's waste-heat load but also to carry it away, and dissipate it into the atmosphere. These conditions enable evaporative water-cooling equipment to function. The physical properties of air that are most important to waste-heat disposal with evaporative water-cooling equipment are: Wet-bulb temperature, dry-bulb temperature, humidity, total heat in Btu, pressure, weight, and velocity.

Wet-Bulb Temperature

The wet-bulb temperature of the air is a primary factor in designing, sizing, and selecting of evaporative water-cooling equipment. The wet-bulb temperature is determined by whirling a wetted thermometer-bulb in the air until a consistent reading is obtained. Total heat (latent plus sensible) of the air may be determined from its wet-bulb temperature. Water can be cooled by the evaporative method until its temperature is lowered to the air's wet-bulb temperature. In practice, however, water is cooled to a temperature approaching the wet-bulb. The closer this approach the larger the size of the cooling equipment required for a given duty.

EXCLUSIVE

Since any change in the total heat of air is accompanied by a change in its wet-bulb temperature, it can be seen that this temperature will vary with different locations, seasons, and weather conditions. The wet-bulb temperature used for the design of evaporative water-cooling equipment is generally close to the average maximum wet-bulb for the summer months at that location. The exact wet-bulb temperature thus selected is determined largely by operating conditions, temperature limitations, and geographical location.

Operating Terms

Those who operate or manufacture distinctive major mechanical equipment or apparatus gradually develop a somewhat specialized "glossary" of words and phrases that describe particular related functions, parts, or characteristics of such equipment. The most common of such terms as applied to atmospheric water-cooling equipment are the following:

Cooling Range (Fig. 2) is the degrees F that the water is cooled with the water-cooling equipment. It is the difference in temperature between the hot water coming to the cooling tower and the temperature of the cold water leaving the tower.

Approach (Fig. 2) is the difference in degrees F between the temperature of the cold water leaving the cooling tower and the wet-bulb temperature of the surrounding air.

Heat Load is the amount of heat dissipated by the water-cooling tower in Btu per hour (or per minute). It is equal to the pounds of water circulated times the cooling range.

Pumping Head (Fig. 3) is the pressure required to lift the water from the top of the water in the basin to the top of the tower and force it through the water distribution system. It is equal to the static heat plus the velocity head and friction loss in the distribution system.

Drift is the small amount of water that escapes from atmospheric water-cooling equipment in the form of fine droplets and is that water which is entrained by the circulating air. Drift is a water loss independent from that water lost by evaporation; it can be reduced by good design.

Blow Down (bleeder by-pass or waste) is the continuous or intermittent wasting of a small part of the circulating water in order to minimize harmful concentrations of chemicals in the water. The purpose of blow down in the water-cooling equipment is to reduce the dissolved solids, or hardness, and thus the scale-forming tendencies of the water.

Make Up water is that required to replace the water lost by evaporation, drift, and blow down.

Cooling Range

As defined previously, the cooling range (Fig. 2) is the degrees F difference between the temperature of the hot water entering the cooling tower and the temperature of the cold water leaving the tower. The cooling range may be determined by dividing the total heat to be dissipated in Btu by the pounds of cooling water circulated.

$$\text{Range} = \frac{\text{Btu per min heat load}}{\text{gpm} \times 8.33 \text{ lb/gal}}$$

This equation indicates that for a given heat disposal problem the cooling range can be made any desired amount by increasing or decreasing the quantity of water circulated.

Choice and use of the proper cooling range depends upon the type of service such as refrigeration, steam condensing, engine jackets, refinery, etc., and also upon the desired cooling effect or efficiency, the mechanical and physical limitations of the equipment, the effect of the water circulated upon the heat transfer rate, the design wet-bulb temperature, and the type of water-cooling equipment. The cooling range may vary in amount between certain limits for various types of installations, as given in the examples following.

Typical Problems

1. *Refrigeration:* Cooling range 5 to 10 F.

Data: 300 tons refrigeration, Freon 12 as refrigerant. 4.0 gpm per ton, cooling-water circulated. Assume cooling tower heat load as 50 Btu heat of compression + 200 Btu refrigeration load = 250 Btu per min per ton.

Solution:

$$\text{Range} = \frac{300 \text{ T} \times 250 \text{ Btu/min/T}}{4.0 \times 8.33 \times 300 \text{ T}} = 7\tfrac{1}{2} \text{ F}$$

2. *Steam Condenser:* Cooling range 10 to 20 F.

Data: 30,000 lb steam per hour to be condensed. 4750 gpm cooling-water circulated. Assume 1000 Btu per pound removed in condenser and dissipated by water-cooling tower.

Solution:

$$\text{Range} = \frac{30{,}000 \text{ lb} \times 1000 \text{ Btu/lb}}{4750 \times 8.33 \times 60} = 14 \text{ F}$$

3. *Diesel Engine Jackets:* Cooling range 10 to 25 F.

Data: 1200 bhp of Diesel engines, 0.30 gpm per bhp cooling-water circulated. Assume 2800 Btu per bhp-hr to be dissipated by the water-cooling tower.

Solution:

$$\text{Range} = \frac{1200 \text{ bhp} \times 2800 \text{ Btu/bhp-hr}}{0.30 \times 8.33 \times 60 \times 1200 \text{ bhp}} = 18.7 \text{ F}$$

4. *Petroleum Service:* Cooling range 20 to 50 F.

Data: 104,250,000 Btu per hr to be dissipated. 6950 gpm cooling-water circulated.

Solution:

$$\text{Range} = \frac{104{,}250{,}000 \text{ Btu/hr}}{6950 \times 8.33 \times 60} = 30.0 \text{ F}$$

Types, selection, construction, operation, and maintenance of water-cooling equipment will be presented in near-future issues of *The Petroleum Engineer.*

* * *

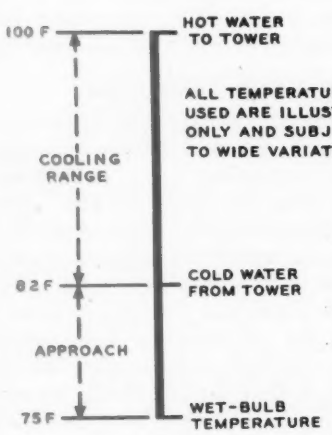


FIG. 2. Schematic definition of the terms "cooling range" and "approach."

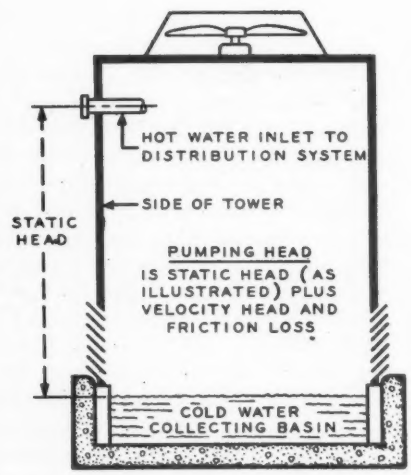

HOT WATER INLET TO DISTRIBUTION SYSTEM
SIDE OF TOWER
STATIC HEAD
PUMPING HEAD IS STATIC HEAD (AS ILLUSTRATED) PLUS VELOCITY HEAD AND FRICTION LOSS
COLD WATER COLLECTING BASIN

FIG. 3. Schematic definition of "static head" and "pumping head," as applied to an induced-draft cooling tower.

EXCLUSIVE

Stuffing Boxes for Centrifugal Pumps

V. LOBANOFF*

THE rotating shaft in all centrifugal pumps must come through the stationary casing into the atmosphere in order to be supported by the bearings and to be coupled to the driver. To prevent pumped liquid from escaping into the atmosphere, a stuffing box is formed around the rotating shaft. It consists of a cylindrical body, which is either cast integral with the pump case or bolted to it, and which is formed around the pump shaft. The space between the shaft and the cylindrical body is usually filled with pliable packing or with a double or single mechanical seal. The function of a stuffing box is to prevent leakage along the shaft. Usually, however, the packing or mechanical seal minimizes the leakage rather than prevents it completely.

In the modern high speed centrifugal pump, a stuffing box has many and varied problems. These problems are due to the large variation in temperatures, pressures and corrosive and abrasive elements in the pumped liquids.

Considerable progress has been made in recent years in the development of mechanical seals, but is still limited to the lower temperatures, clean liquids and medium pressures. Where cold abrasive liquids are pumped, a single seal usually requires auxiliary equipment to filter the abrasives from the liquids or it requires an oil filled double mechanical seal installation. Several pump manufacturers have developed a stuffing boxless pump but its extremely high cost is only justified by very special applications.

The majority of high speed centrifugal pumps are still equipped with stuffing boxes fitted with pliable packing as a sealing medium.

It is very important to select the proper type of packing material. It is even more important to select the proper design of a stuffing box for each specific service.

Each industry has a lot of experience with the packing material and each favors some particular make of packing. This is mainly due to the human element that enters into the art of packing the pump and to the training and experience of operating personnel.

The design of a stuffing box usually depends on the pump manufacturer. It is essential to the successful operation of the stuffing box that the pressures and the temperature on the packing is kept as low as possible. The abrasives, corrosives, and volatile liquids must also be kept away from the packing. This usually can be accomplished by bleed off connections to maintain low pressure and by injection of clean cold liquid ahead of the packing to keep abrasives from entering into the packing material.

To illustrate different types of stuffing box design, several schemes are presented in this paper.

Fig. 1 shows a standard stuffing box designed for low pressures and temperatures and for stable and clean liquids. It should be packed with a completely soft packing. When pump liquid is under vacuum on the suction side, a lantern ring is installed in the middle of the stuffing box for liquid sealing. The same lantern ring can also be used for grease lubrication if desired.

The design shown in Fig. 2 is most commonly used for pumps in the processing industries. The stuffing box is water jacketed, has eight or nine rings of packing and a lantern ring in the

*Assistant Chief Engineer, United Centrifugal Pumps, Division of United Iron Works.

FIG. 1

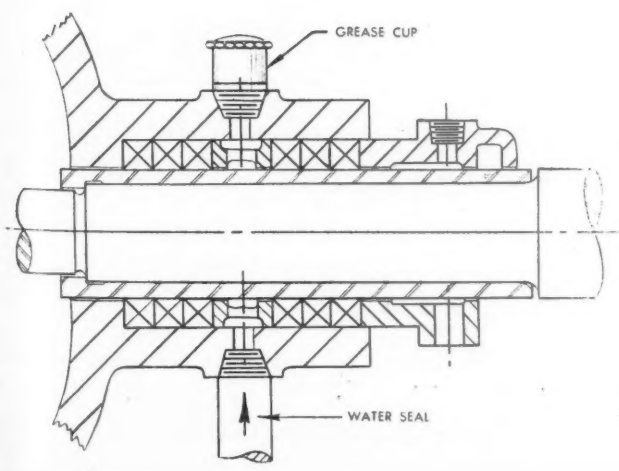
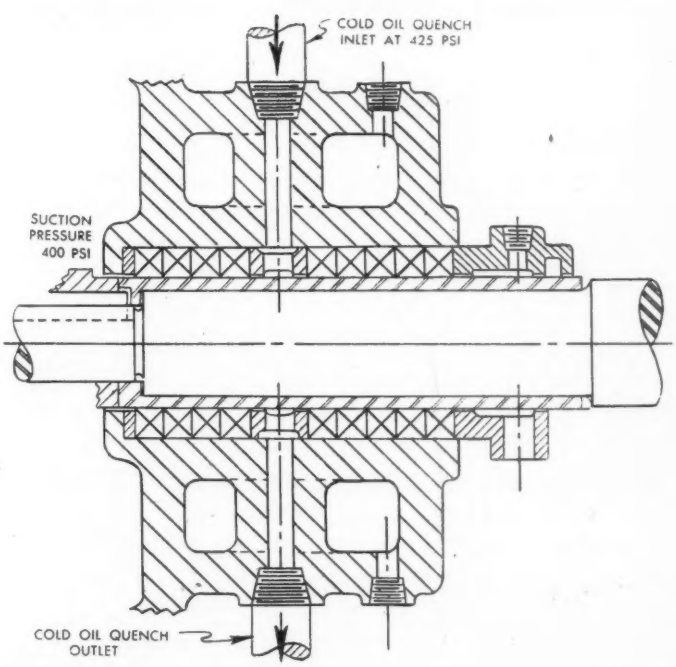


FIG. 2



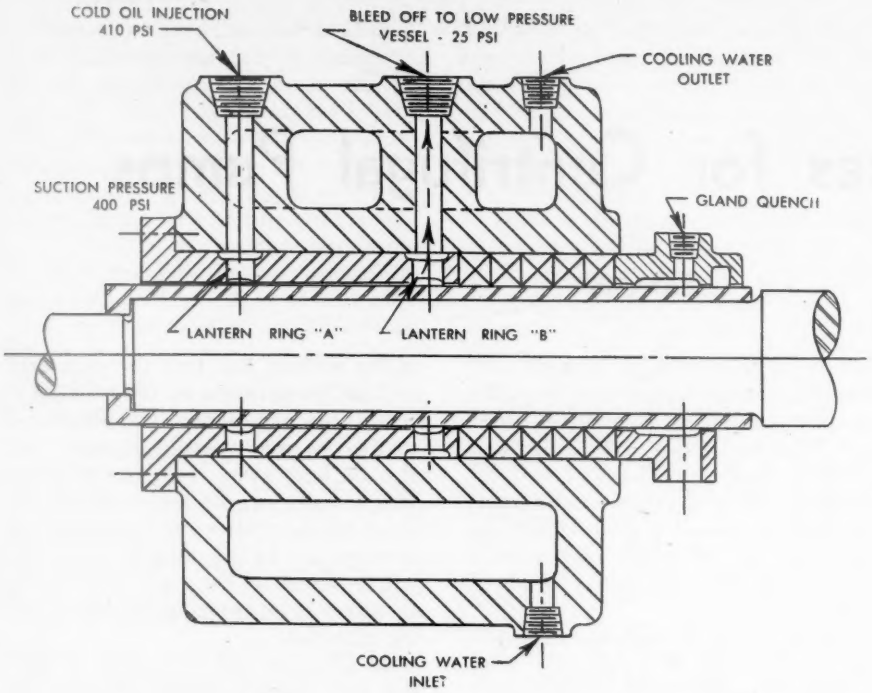


FIG. 3

middle of the stuffing box. It is designed for medium pressures and temperatures up to 800 F. When handling liquids under high temperatures or volatile liquids, cold liquid is injected into the lantern ring at pressures from 15 to 25 psi higher than suction pressure. The injected oil will seal the pumped liquid within the pump casing and will allow the packing to operate with good lubrication under low temperature, with pressures slightly higher than the suction pressure of the pump. Only a small amount of injected liquid will flow into the pump and the contamination effect is practically negligible. For the packing, die-formed rings of either lead, copper or aluminum foil should be used, depending upon the temperature and the type of liquid being pumped. The shaft sleeve is protected by a hardened surface under the packing with a ground and polished surface.

Fig. 3 shows a stuffing box design for handling high temperature, high pressure liquid. It allows packing to operate under low pressure and low temperature and offers considerable saving in maintenance of stuffing box parts. It consists of a long throttle bushing with two lantern rings, one, "A," at the bottom of the stuffing box and one, "B," next to the packing. The cold oil is injected into the lantern ring "A" at pressures slightly higher than suction pressure. The cold liquid will flow through the gap between the bushing and sleeve, into the pump and into the lantern ring "B." Due to the small pressure drop, only a small amount of injected liquid will flow into the pump. The greater amount will flow into the lantern ring "B," which is piped to a low pressure vessel, usually the injection oil supply tank, which is open to the atmosphere. This stuffing box design subjects packing to low pressure and temperature and insures long uninterrupted stuffing box life. To minimize the leakage through the throttle bushing, higher viscosity oils are recommended as an injection medium.

Many installations require the operation of two or three pumps in series to obtain the required discharge pressure. With this arrangement, the last pump stuffing box is subjected to extremely high pressures, sometimes up to 5000 psig. Fig. 4 shows a stuffing box design mostly suited for high pressure, low temperature service. It has a long breakdown bushing and a leak off chamber, which is piped to the sump under atmospheric pressure. The length of a breakdown bushing is determined by the total pressure drop from the bottom of the box to the leak off chamber. A 250-lb pressure drop per inch of length usually assures low wear factor of the bushing. The leakage is minimized by small clearances between the rotating shaft and the bushing. Eight to ten thousandths diametral clearance is found practical for shafts from three to four inches in diameter, and four to six thousandths diametral clearance for smaller shafts. For this stuffing box design it is important to select nongalling material

FIG. 4

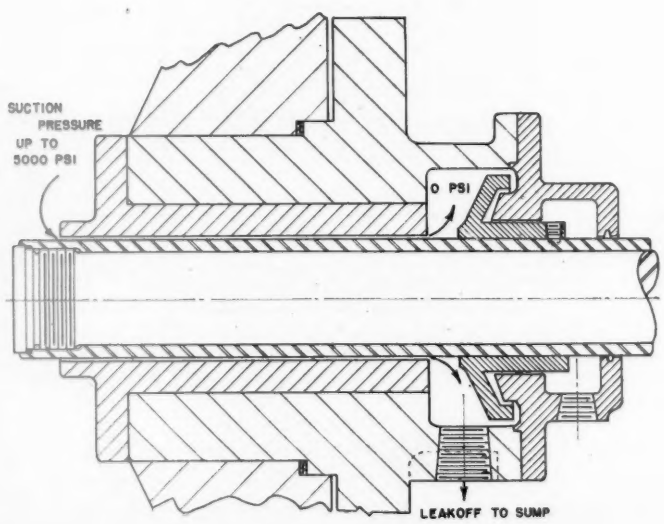
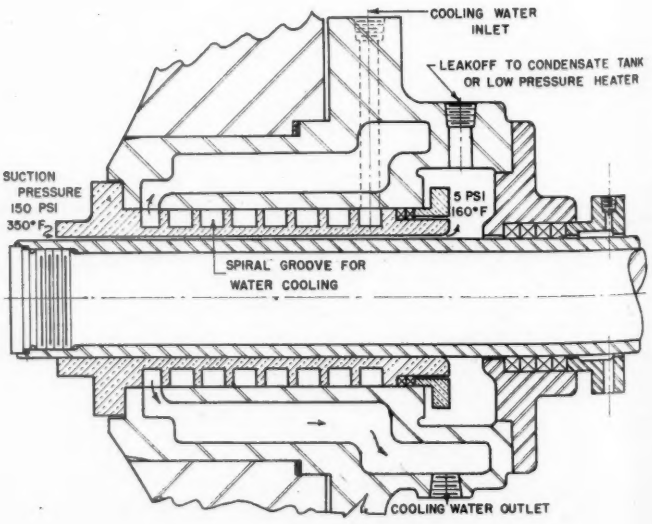


FIG. 5



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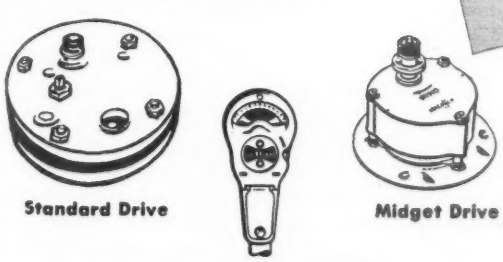

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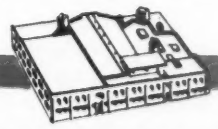

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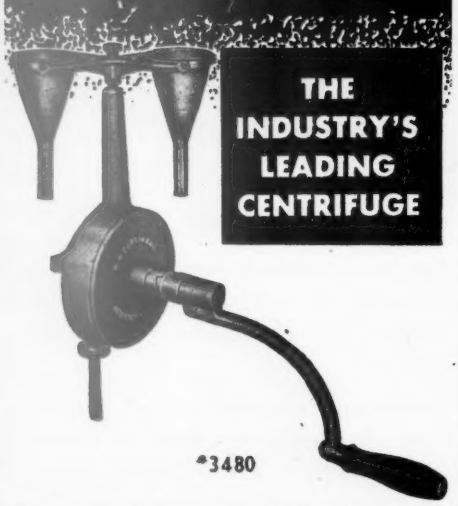

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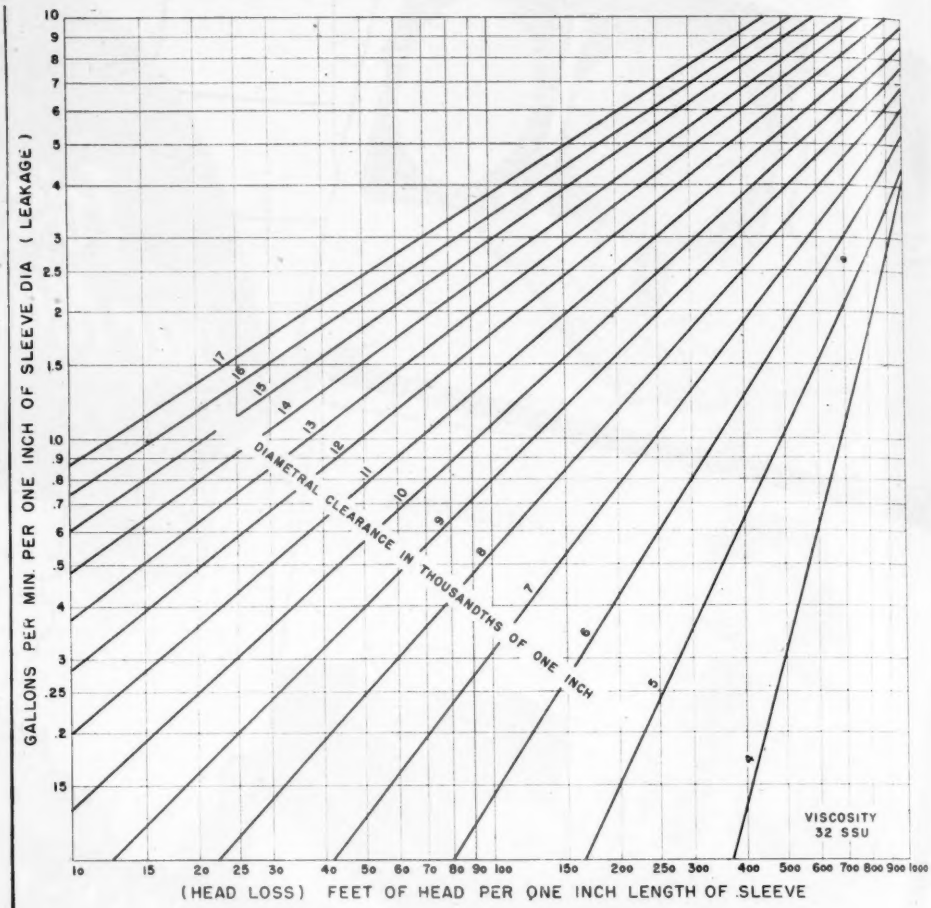

GALLONS PER MIN. PER ONE INCH OF SLEEVE DIA. (LEAKAGE)
DIAMETRAL CLEARANCE IN THOUSANDTHS OF ONE INCH
VISCOSITY 32 SSU
(HEAD LOSS) FEET OF HEAD PER ONE INCH LENGTH OF SLEEVE

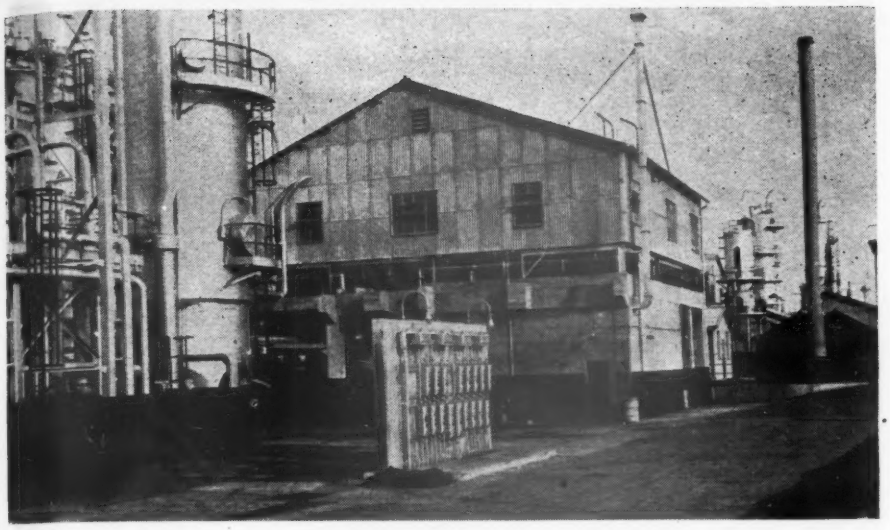
FIG. 6

for the bushing and the shaft or the shaft sleeves. Bearium bronze bushing material, running against hardened 11.5-13 per cent chrome sleeve, is an excellent combination for this service.

Fig. 5 shows the design of a stuffing box for a pump handling boiler feed water up to 300 F temperatures. This design assures long life of usually expensive shaft sleeves. It entirely eliminates loss of condensate water through the stuffing box. Due to the continuous flow of water through the bushing, even when the pump is not in operation, the warming of a pump is automatically achieved, entirely eliminating a manually controlled warming line. This stuffing box consists of a long breakdown bushing, having a spiral groove for conveying cooling water through the full length of the bushing. The hot boiler feed water flowing between the bushing and the sleeve is cooled far below the flash point and the pressure, due to the close clearance of the bushing, is reduced to the atmospheric pressure. The leakage from the bushing flows into the leak off chamber, which is piped to the condensate storage or to the low pressure heater. This design has achieved very good results for the high speed, high pressure, boiler feed pump. It is also adaptable to temperatures higher than 350 F for some of the smaller feed pumps. The leakage is a function of the shaft diameter and the small shaft minimizes the leakage, increasing the cooling effect of the bushing.

The total amount of leakage can be calculated for the breakdown or throttle bushing on a centrifugal pump. The leakage loss is a function of a pressure drop, shaft diameter, length of a bushing and the diametral clearance between the seelve and the bushing. The accompanied chart shows leakage loss per inch of sleeve diameter for varied pressure drops and clearances. It is based on liquid with viscosity equal to water. The leakage loss through the bushing for viscous oil will be less than shown on the chart of the exact values have to be determined experimentally. As shown on the chart, however, the leakage loss values can be used for approximation on the conservative side.

The different schemes of stuffing box design shown in this paper do not cover the whole field of centrifugal pumps, but they indicate that many stuffing box problems can be solved successfully by using the proper design of a box for a given service. * *



Panel in foreground contains electrical controls from which the entire plant can be shut down in an emergency.

Rotary Filters Added to Propane Dewaxing Plant

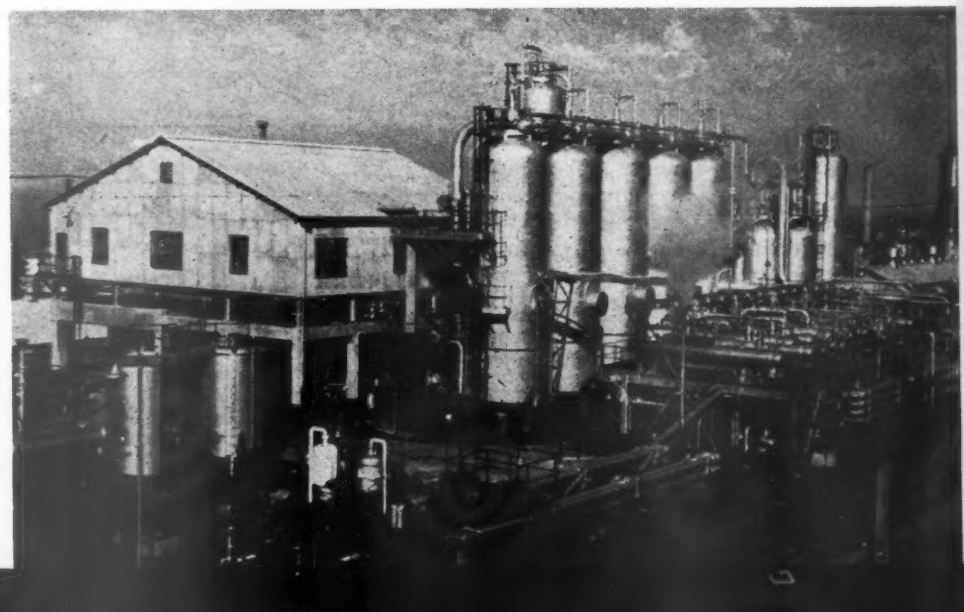
J. C. ALBRIGHT

In line with the expansion program of Union Oil Company of California at Oleum, the propane dewaxing plant was revamped to include rotary filters so as to process a greater quantity of paraffinic waxy long residuum and to produce a better grade of lubricant. The propane plant was originally designed and built to process definite SAE grades of oil, separately and with a semi-batch operation. After the change-over was made, the plant has a daily capacity of 1900 bbl per day, charge to the unit, with a yield of 1425 bbl per day of dewaxed full range lubricating oil stock, which is then ready to be vacuum distilled to produce the cuts, such as SAE 10, 20, and 30-wt oils and the like.

The feed to the propane dewaxing plant is a waxy, full-range raffinate produced by solvent refining in a new Duo-Sol plant, recently completed and placed on full stream. The feed, as it comes from the solvent refining unit, is stored hot in adequate tankage from which it flows by gravity to the suction of the propane charge pumps. These pumps discharge at a pressure of 550 psig to a shell and tube waxy charge heater serviced with exhaust steam to raise the temperature of the waxy charge to 200 F. The charge then flows through an 8-in. Duriron mixer in which one volume of oil and two volumes of propane at 110 F are mixed thoroughly. Obviously, when propane is added the temperature will fall, and it is again raised in a shell and tube exhaust steam heater to 180 F, or between 20 and 30 deg above the melting point of the wax, depending upon the characteristics of the charging stock. The purpose of raising the temperature of the blend of waxy oil and the propane to about 180 is to insure complete solution of the oil and the propane, after which the material is chilled to — 50 F to produce a zero pour point dewaxed lubricating oil.

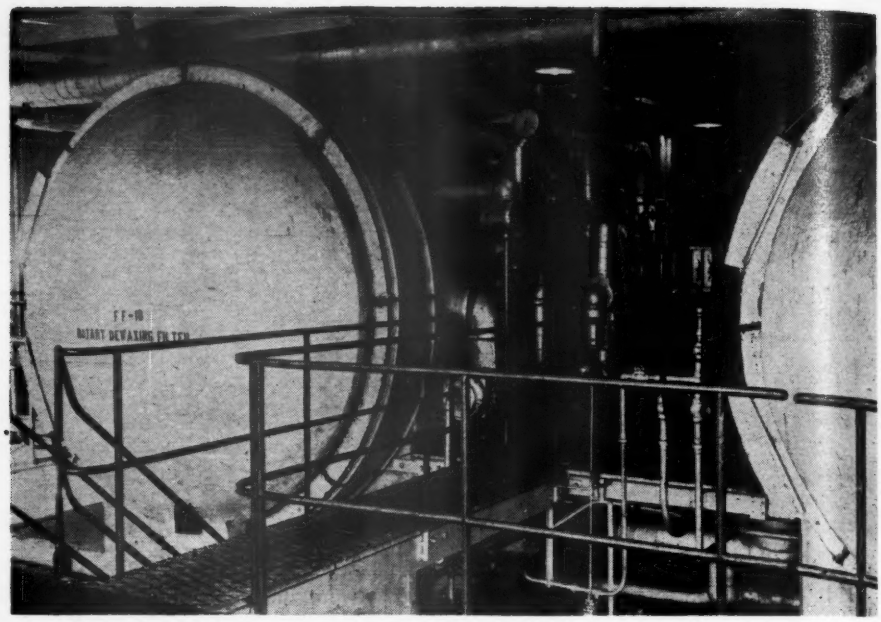
The chillers are four in number, equipped with various instruments and fittings with the necessary piping to fill, empty, chill, and remove the propane vapors with compressors. These chillers are operated in continuous batch with timing so that one chiller is being emptied, another filling, one chilling and another warming up, requiring a time cycle of 160 min for a complete operation, with an arrangement for the chillers to be operated 40 min apart in the sequence of operation. The warm waxy solution is transferred from the surge tank to a warm and empty chiller without pumping as the pressure differential between the stock, or surge tank and the warm chiller is enough that the quantity required will flow unassisted. Intake lines leading to the propane compressors remove the vapors from the chiller as the temperature is reduced, due to evaporation of the liquid propane. Make-up propane is added constantly to the chiller as the temperature is being reduced to minus 50 deg so that continuous formation of wax crystals will result. In the operation to remove propane from the chiller, the compres-

EXCLUSIVE

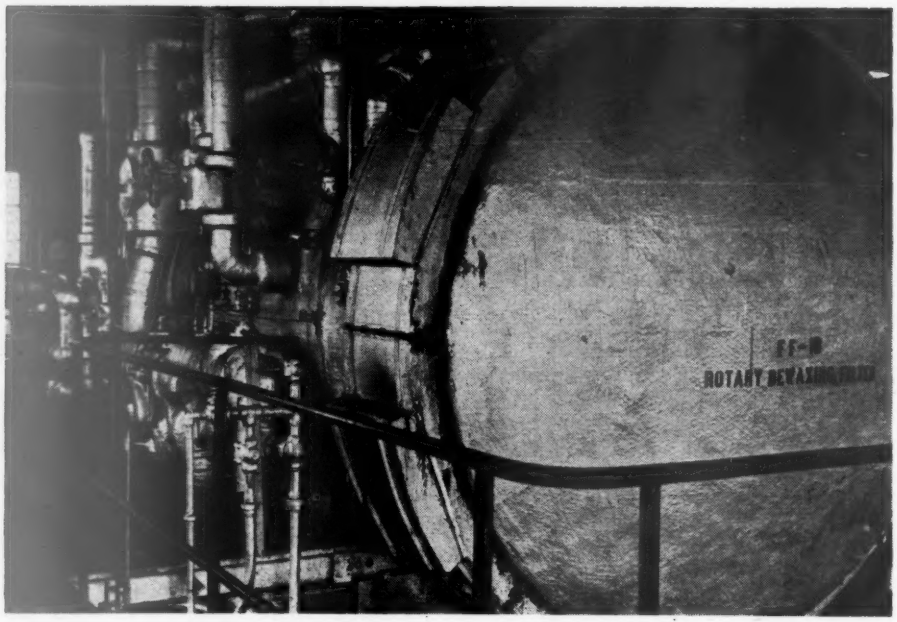


Union Oil Company of California's propane dewaxing plant, recently streamlined with the addition of two large rotary filters for the removal of waxes from the — 50 F lube oil solution. Vertical vessels are the propane chillers.

Inlet and outlet lines in rotary filters in revamped lube oil dewaxing unit.



Control side of rotary dewaxing filter in plant. Filters are installed in second story of building to supply flooded suction to process and evacuating pumps on ground level.



sor intake lines are equipped with automatic unloading devices so that suction begins at 110 psia and ends at 12.1 psia. As the propane is removed from the chiller, cold propane make-up at about — 15 F is added to the "batch" at a constant rate in the top of the chiller more propane is added than is removed from the mix so that, at the end of the chilling operation, the propane-waxy oil ratio is about 3:1.

At the end of the chiller operation cycle, the crystalline wax, the oil and the propane as a slurry is transferred at — 50 F by pressure differential from the chiller to the filter feed tank. The temperature on the slurry in the filter feed tank is held at — 50 F with a suction of 12.1 psia supplied by the propane compressors with sufficient propane added to the tank to compensate for that removed by evaporation and by the suction of the propane compressors. The pumps which transfer the cold slurry to the filters has a submerged suction, or gravity feed, with the discharge maintained at about 47 psig. The transfer pumps deliver the slurry to the feed pan of the huge Oliver rotary filters in a constant volume to maintain a drum submergence of approximately 45 per cent. As the drum rotates slowly, the cold slurry is picked up on the filter cloth. By a pressure differential arrangement, the inner side of the drum has from 3 to 5 psig less pressure than that inside the filter case (outside the drum) so that the pressure differential tends to force the propane-oil through the cloth to the drum where it is collected and flows to the dewaxed oil accumulator.

The crystalline wax in the slurry collects on the outside of the cloth as an oily cake, is continuously washed with fresh propane at — 50 F to remove all the oil possible. As the blow gas bulges the cloth intermittently, the cake is broken away and is scraped away from the drum by the deflecting blades so it collects in a trough as a slurry, formed by additional propane, so that it can be pumped readily. A screw-type conveyor delivers the waxy slurry to the suction of the petrolatum solution pump, which discharges at a pressure of 30 psig into the suction of a second pump. This arrangement of two pumps has been found advantageous by providing a constant head-feed to the booster pump by the low pres-

TABLE 1

	High oil dewaxed			High wax dewaxed		
	Feed	Oil	Wax	Feed	Oil	Wax
Gravity, API	30.5	27.2	34.0	31.0	27.9	34.5
Viscosity index	112	88	.....	117	99	.....
Vis-gravity constant	0.800	0.822	.....	0.798	0.817	.....
Pour point (max) F	130	—10	.....	130	—10	.....
Solid point	.....	—16	.....	.....	—14	.....
Con. carbon — weight, per cent	0.14	0.15	.....	0.12	0.11	.....
Flash COC F	430	.....	.....	465	.....	.....
Fire COC F	505	.....	.....	535	.....	.....
Vis SSU at 100	.....	579	.....	.....	549	.....
Vis SSU at 150	120	.....	.....	112	.....	.....
Vis SSU at 210	59	66	.....	57	64	.....
ASTM pet. melt point F	.....	.....	151	.....	.....	147
ASTM oil cont weight, per cent	.....	.....	2.2	.....	.....	3.1

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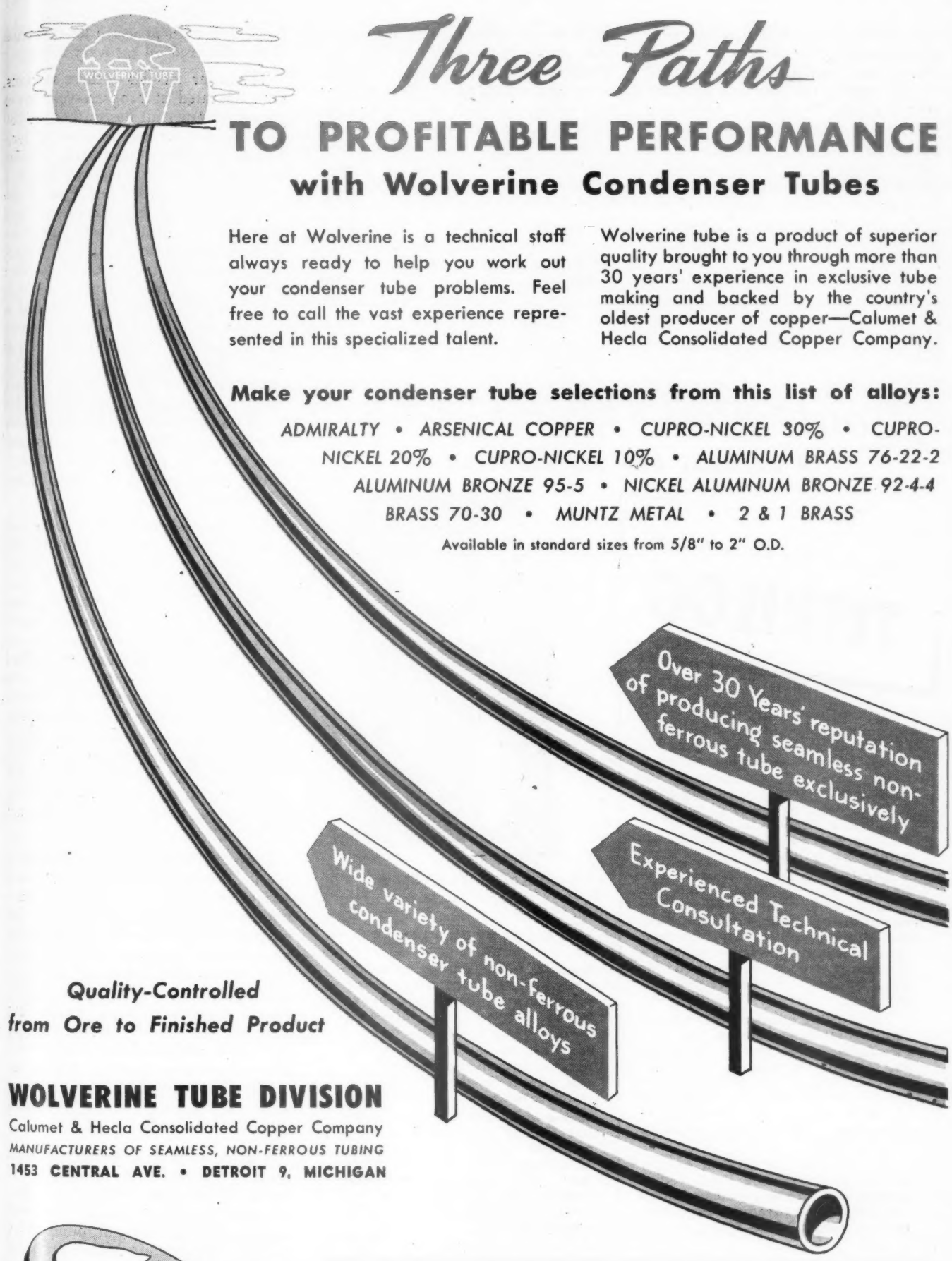
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sure primary unit and that plugging of lines and intake ports is prevented. The second pump discharges at a head of 350 psig to the wax and propane recovery unit. Two rotary filters are operated in this plant in a parallel position so that each unit receives an equal amount of oil-propane-wax slurry from the feed tank immediately downstream from the chillers.

The dewaxed oil-propane solution is pumped through heat exchangers to bring the temperature up in stages to about 72 F when it enters a three-section series-operated interchanger to bring the temperature up to about 135 deg with an exchange with a propane-wax slurry in the tubes at 180 deg. This 135-deg oil-propane solution then is introduced into a horizontal reboiler type heater with exhaust steam in the tubes to increase the dewaxed solution to about 180 deg where approximately 90 per cent of the propane is flashed off from the solution. Immediately downstream from the primary flash heater, the dewaxed oil and the remainder of the propane are passed through a vertical shell and tube heater, serviced with 150-lb live steam to bring the temperature up to about 300 deg, from which the hot solution flows to a high pressure flash section of the dewaxed oil recovery tower.

The tower consists of three sections, each operated at progressively lower pressures to permit flashing off at 230 psig without further increase in temperature. In the atmospheric section, the pressure is dropped to about 1 psig where about 95 per cent of the remaining propane is flashed off and removed from the system with the holding compressors in the propane compression engine room. To extract the remaining traces of propane from the dewaxed product, the material is pumped through a vacuum column with 26 in. held on the system and at 290 F, from which the dewaxed lubricating oil stock flows through coolers and to storage. This storage is provided for dewaxed oil and as a feed tank for another step in Triton motor oil manufacture, where the dewaxed stock is Filtrol Fractionated to the desired SAE grades.

The wax-propane slurry is transferred through several economically operated heat interchangers to the stripping column, which, like the oil-propane unit, contains three separate pressure stages so as to remove essentially all of the propane. Propane removed from the wax slurry is handled by the engine room compressors to be liquefied for constant reuse. Depropanized wax leaving the final propane extraction unit is cooled from about 290 deg to storage temperature. Wax follows through another unit for de-oiling, classification and fractionation into melting point specifications and slabbing.

Propane employed in the dewaxing plant, for refrigeration purposes should be 100 per cent pure, as either butane or ethane is unsuitable for the purpose. As gas is employed as "blow gas" to break the wax cake from the filter drum cloth covering, however, it is desirable to employ some ethane. Ethane remains essentially a vapor but propane will liquefy under filtering operations, and this hydrocarbon fraction follows through the system to the purge tank from which it is removed to be used again as "blow gas" with certain volumes of propane.

The revamped propane dewaxing plant at Oleum has been designed to dewax a full range waxy raffinate produced by the Duo-Sol unit by solvent treating a long residuum obtained by topping San Joaquin Valley crude. It handles equally well either of two types of raffinate; one with a maximum oil yield of 75 per cent and a minimum oil yield of 65 per cent. Feed and products are shown in Table 1. * * *

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For complete information on the Consolidated Titrilog and other applications, such as problems in corrosion, sour-gas treating, etc., write for Bulletin CEC-1810-X7.

SPECIFICATIONS

Sensitivity The Titrilog quantitatively records oxidizable sulfur compounds in concentrations as low as one part in ten million or 0.005 grains per 100 cubic feet.

Power Requirements The Titrilog operates on standard 60-cycle 115-volt power. It requires approximately 6 amperes.

Cabinet Dimensions The Model 26-102 Titrilog is housed in a floor-mounted cabinet 66-inches high, 22½-inches wide, and 18½-inches deep. The strip-chart recording milliammeter is mounted at eye level, and directly below it is the control panel.

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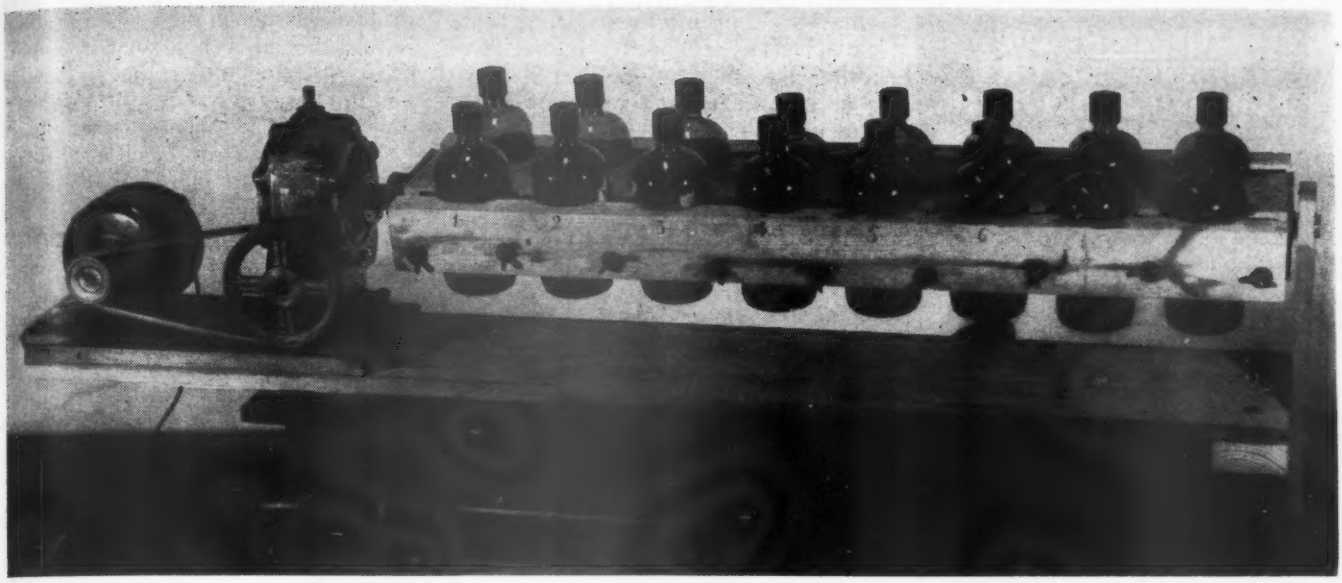

Sixteen-stage large scale laboratory extraction apparatus.

Laboratory Extraction Apparatus

H. L. LOCHTE and W. G. MEINSCHEIN*

WHILE solvent extraction has become a well known operation which is extensively used in industry and in pilot plant studies, laboratory equipment used still consists mainly of separatory funnels or modifications or of small scale packed or unpacked columns of various types.

In biochemical work in which very small fractions can often be studied profitably, an ingenious apparatus has been developed, studied, and used by Craig and co-workers.[2] Results obtained with this apparatus have been so satisfactory that it has become practically standard equipment in biochemical laboratories.

In 1932 Jantzen[3] described an apparatus using ordinary glass U tubes suitably connected and mounted on a shaft in such a way that they can be rotated end over end. This apparatus has been in use for some time in the University of Texas laboratories. As the U tubes have a capacity of 125 ml they can be used to study larger samples than the Craig machine, but even then, as the material usually has to be present in dilute solution, the amount of mixture that can be fractionated is still too small to permit collection of a number of fractions each of which may have to be carried through a number of reactions.

In the study of carefully fractionated petroleum acids it became desirable to be able to work with distillation fractions with an original volume of one to two liters. Obviously the U tube apparatus could be used only by making an excessive number of runs, and pilot plant columns would have to be too tall for use in an ordinary laboratory. To deal with such large samples of acids, a large scale distributor was designed and constructed and was found to be simple and efficient in operation.

In the machine as used at present 16 screw cap quart bottles are clamped, eight to a side, to a 42-in. block of 4 in. by 6 in. wood, which has notches on two opposed sides for the 16 bottles. Strips of rubber are used as liners in the notch to permit secure fastening of the bottles without danger of crushing them. Short lengths of 1 in. steel shafting are inserted into the ends of

*Chemical Laboratory of the University of Texas.

TABLE 1.

Period	Bottle [1]	Bottle [2]	Bottle [3]	Bottle [4]	Note
1	¾ acids ¼ salts ¼ acids	¼ NaOH 2/4 acids	¼ NaOH	¼ NaOH	
2	Na_2SO_4 P. E.	¼ salts ¼ acids	¼ NaOH ¼ acids	¼ NaOH	(a)
3	Na_2SO_4	¼ salts ¼ acids	¼ salts ¼ acids	¼ NaOH P. E.	(b)
4	OUT	Na_2SO_4 P. E.	¼ salts ¼ acids	¼ salts ¼ acids	(a, c)
5		Na_2SO_4	¼ salts ¼ acids	¼ salts ¼ acids	(b, d)
6		OUT	Na_2SO_4 P. E.	¼ salts ¼ acids	(a, d)
7			Na_2SO_4	¼ salts	(b, e, f)

Notes:
(a) One third equivalent of acid added at start to liberate acids from salts.
(b) Fresh petroleum ether (P. E.) added to extract traces of acids from sodium sulfate solution.
(c) Petroleum ether layer contains small amounts of dissolved acids, phenols and salts. Removed before next period.
(d) Top Layer removed as extraction fraction before next mixing period.
(e) Petroleum ether from bottle 3 and top layer of bottle 4 removed as cut 3.
(f) Bottom layer of bottle 4 is cut 4.

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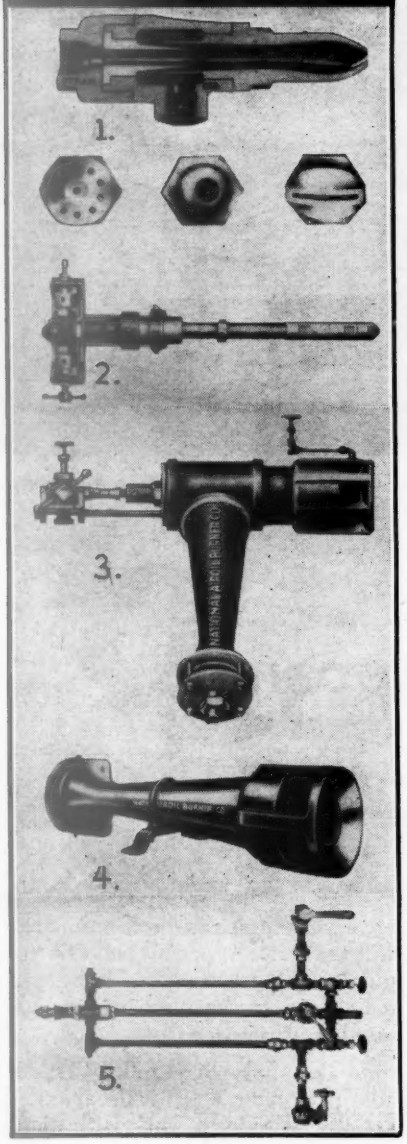
THE *RIGHT* OIL BURNER OR GAS BURNER *FOR YOUR JOB*



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1. (For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressue and temperatures. Send for Bulletin No. 21.

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2. (Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers. Send for Bulletin No. 24.

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3. —the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner, Send for "AIROCOOL" brochure.

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Main Offices & Factory:
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the 4 by 6 in. block; one shaft being attached to a Foote speed reducer while the other end turns in a simple bearing. A fractional horsepower motor turns the shaft at 32 rpm.

As the bottles are not connected by tubing in any manner, the equipment can be used to yield any desired number of stages up to 16 without repassage through the bottles. In preliminary separation of very large fractions 2, 4, or 8 aliquots can be extracted in 8, 4, or 2 stages if desired or 1, 2, 4, or 8 different samples can be fractionated at the same time. This permits preliminary crude separation of a large sample followed by more efficient fractionation of one or more of the preliminary fractions. Extraction with reflux can be carried out or separation of pairs or types can be carried out by introducing the mixture to a central bottle as in the case of continuous fractionating towers.

To illustrate the operation of the equipment, the steps involved in a 4 stage separation of acids by fractional neutralization and liberation are presented below.

One fourth equivalent of dilute sodium hydroxide solution is placed into each of 4 bottles. One equivalent of the mixture of acids is added to bottle 1 and sufficient petroleum ether to fill it to within an inch of the neck. The apparatus is rotated for 10 min although equilibrium appears to be obtained within 5 min. As soon as the phases have separated completely the top layer of bottle 1 is sucked into bottle 2 by means of a water pump connected to one hole of a two hole rubber stopper in the neck of bottle 2, while the other hole of the stopper carries Tygon tubing that is inserted into bottle 1 to remove the top layer. In case sharper separation of phases is required this can be effected by inserting the two hole stopper in the neck of a suitable separatory funnel and then returning the heavy phase to bottle 1 before transferring the light phase to bottle 2. Fresh petroleum ether is then poured into bottle 1 along with ⅓ equivalent of 1:1 sulfuric acid. Another 10-min mixing period follows. Table 1 shows the situation obtaining at the end of each period of rotation.

The machine is stopped with all bottles in upright position, which is an improvement over an earlier machine in which gallon bottles were attached to the spokes of a rimless wheel.

Craig describes two types of glass extractors that could be designed to permit use of larger samples and quite recently O'Keefe, Dolliver, and Stiller[4] have described a similar apparatus in which satisfactory funnels are used instead of bottles. This scheme has the advantage of permitting sharp separation of phases without using any additional operation and so should be faster for precise work, but like Craig's, it employs glass stoppers and stopcocks that may be open and result in loss of sample.

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2. Craig and Post, Anal. Chem. 21, 500 (1949).
3. Jantzen, Dechema Monograph, "Das fraktionierte Distillieren und das fraktionierte Verteilen." Verlag Chemie, Berlin 1932.
4. O'Keefe, Dolliver and Stiller, J. Am. Chem. Soc., *71*, 2452 (1949).

* * *

Western Petroleum Refiners Association Plans Technical Meet

A full program of important subjects to refiners is arranged for the three technical sessions provided for during the March 27-29 meeting of the Western Petroleum Refiners Association at the Plaza Hotel, San Antonio, Paul Williams, WPRA technologist, announces. For the two general sessions of the meeting speakers of national caliber are to present some of the most important and difficult problems now faced by the industry to those attending the meeting, John Day, executive secretary of the association, points out.

The first technical session, which starts at 2:00 p.m. on Monday, March 27, is devoted to diesel and motor fuels. A. J. McIntosh of Socony-Vacuum Oil Company will discuss future motor fuel demands; a representative of the automotive industry will present the trends in that industry in engine design and fuel requirements; and the chairmen of the motor fuel and the diesel fuel committees of the association will present their annual reports. The second technical session will start at 9:30 a.m. March 28. The third technical session will be held on the following morning and announcements regarding papers will appear later. One of the papers to be given at one of these sessions is that of Dr. Vladimir Haensel, of Universal Oil Products Company, who will discuss the results of the operation of the Platforming or catalytic reforming process.

In addition papers and addresses will be given by: J. S. Bugas, former FBI agent, athlete, and Ford Motor vice president in charge of industrial relations; W. S. Hallanan, Plymouth Oil Company president and National Petroleum Council chairman; John L. McCaffery, International Harvester Company, and Henry J. Taylor, ABC news broadcaster and economist.

NEWS

Refining Methods, Additives Produce New "Super Lubes"

The last two decades have shown the greatest advances in the art and technology of lubricating oil refining. These advances have been along two main lines—solvent treating methods for refining the heavy petroleum fractions, and the employment of addition agents to improve such properties as oiliness, corrosion prevention, detergency and oxidation resistance of the oil. A recent example of this intensive development is that of the new internal combustion engine oil placed on the market recently by Continental Oil Company.

Improved by the addition of chemical agents proved by laboratory and engine tests to enhance the value of the product on these different points, the new oil reduced the average wear in engines to less than 1/1000 in. during a test program, which included a half-million miles of driving cars and trucks in the heat of a Rio Grande Valley summer. Each engine was driven a total of 50,000 miles in air temperatures up to 110 F in the shade, averaging 50 to 60 miles per hour.

Fire Prevention Groups Meet

The following fire and accident prevention groups under the auspices of the National Petroleum Association, Washington, D. C., have held meetings recently.

The Kentucky-West Virginia group met at the Cabin Creek refinery of the Pure Oil Company for a tour of the refinery, and a discussion of mutual fire and accident prevention experiences. The Bradford-Warren group met and elected Paul Edwards, Socony-Vacuum as chairman. The Tri-State group met at the refinery of the Ohio Oil Company, Robinson, Illinois, for a tour of Ohio's new processing facilities, followed by a discussion of mutual problems. The Michigan-Ohio group met at Findlay, Ohio for a round table discussion of refinery accident and fire experiences followed by a tour through the refinery of the National Refining Company.

Dulien Liquidates Refinery

Dulien Steel Products, Inc., is liquidating the Cotton Valley, Louisiana high octane gasoline refinery, formerly owned by the U. S. government. The plant is situated where it is readily accessible to many of the country's major refinery operations. The plant's equipment is available in part or as a whole and the liquidators maintain a complete staff on the premises.

Sulfur Compounds Available

Samples of eight high purity organic sulfur compounds are available now from the U. S. Bureau of Standards, for sale for use in calibrating and standardizing instruments and similar purposes. The samples have been prepared by the U. S. Bureau of Mines, where they have been used to measure several physical properties of each. The list of these chemicals, their degree of purity, and price are given in the table below.

Ordering instructions are obtainable from The Bureau of Standards, Washington, from which also instructions for transferring samples 'in vacuo' are obtainable on request.

NBS sample number*	Formula	Compound† Name	Amount of impurity‡	Volume per unit△	Price per unit
			mole per cent	ml (liquid)	
904-5S	C_2H_6S	Ethanethiol (Ethyl mercaptan)	0.05±0.04	5	$35.00
905-5S	$C_4H_{10}S$	2-Methyl-2-propanethiol (tert-Butyl mercaptan)	0.08±0.04	5	35.00
906-5S	$C_5H_{12}S$	1-Pentanethiol (n-Pentyl mercaptan)	0.08±0.05	5	35.00
907-5S	$C_2H_6S_2$	2,3-Dithiabutane (Dimethyl disulfide)	0.03±0.02	5	35.00
908-5S	$C_4H_{10}S_2$	3, 4-Dithiahexane (Diethyl disulfide)	0.10±0.08	5	35.00

* The designation "-5S" following the sample number indicates a sample of 5ml sealed "in vacuum" in a special Pyrex glass ampoule with internal "break-off" tip.
† See Chem. Eng. News 24, 2765 (1946) regarding the nomenclature of these compounds.
‡ The purity has been evaluated from measurements of freezing points, as described in J. Research Natl. Bur. Standards 35, 355 (1945) RP 1676, unless otherwise indicated.
△ Tolerance approximately ± 10 per cent.

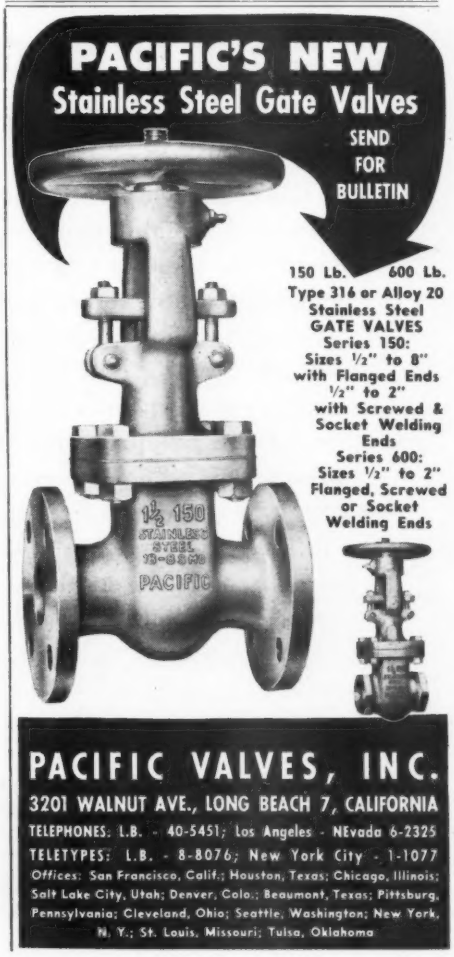
Oil Shale for Future Reserve

Shale oil is our best prospect for oil in the future when petroleum production has fallen below our needs, says S. H. McAllister, associate director of research for Shell Development Company's Emeryville, California laboratories. He told the California section of the American Chemical Society that we have no immediate prospect for depletion of our crude petroleum reserves, but that eventually we may expect shortages. When that occurs, even in the face of our 23.3 billion barrels of oil reserve at present, recovery of oil from shale appears to offer the best possibilities. McAllister stated that we will discover a total of 100 billion barrels of petroleum in the USA eventually, and thus no immediate prospect of shortage exists.

Costs of finding and producing petroleum are rising, he stated, and the margin between the cost of shale oil and petroleum is narrowing, will become more narrow. Present estimates for the cost of mining shale and retorting to produce oil indicate about $2.50 per barrel. This oil may be made fit for use as heavy fuel oil by simple refining operations and it is for this use that shale oil will be applied first, McAllister believes. He does not believe, however, that we should build commercial plants now—no need for them. We should continue intensive research on the recovery and utilization of shale oil in order to have the know-how ready when it is needed. Foreign oil may be obtained but it is neither cheap nor reliable and cannot be depended on in emergency. The Green River-Colorado River drainage basins alone contain 300 billion barrels of shale oil, he said.

Produce New Type Motor Oil

An Australian oil company at Melbourne is producing a type of motor oil which, it is claimed, will adhere to cylinder walls under all types of conditions. The oil contains a profusion of pure castor oil. Tests have shown that a permanent viscous film is left on all reciprocating points even when the motor has cooled off.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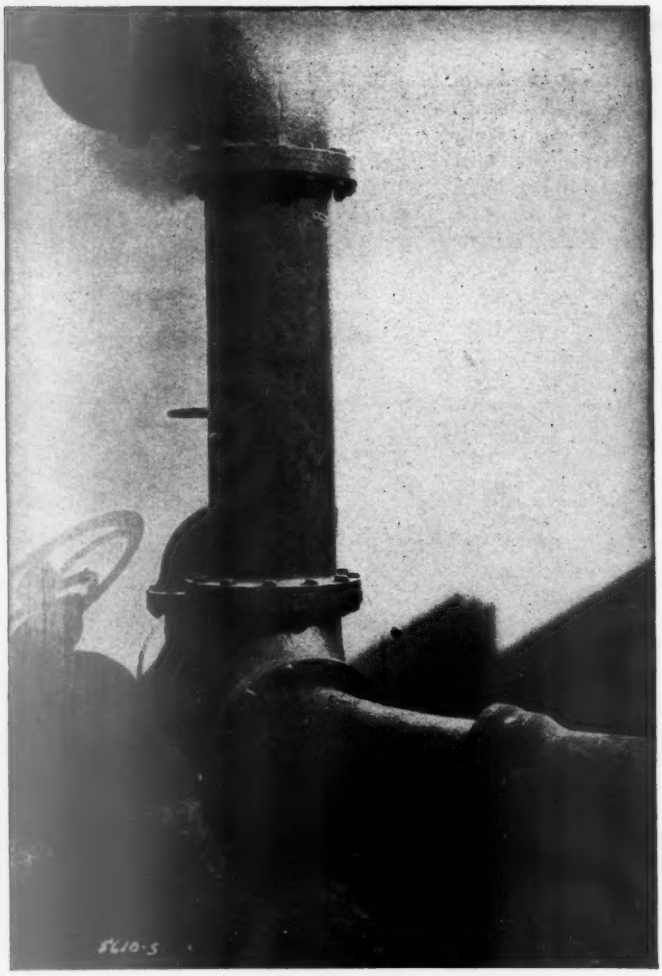


AN ALLY IN THE BATTLE
OF MAINTENANCE COST

Oil refinery operation is known for close control of maintenance cost. One of the factors in keeping this cost low is the dependable, durable service of cast iron pipe. For such refinery services as salt water disposal, cooling and condensing coils, rundown lines, discharge lines, and water and fire protection lines, the cost of cast iron pipe per service-year is low. Measured by that *real* cost, it is cheapest in the end. Available in bell-and-spigot, plain end or flanged, or with standardized mechanical joints. Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 1015 Peoples Gas Bldg., Chicago 3, Illinois.

CAST IRON PIPE
FOR LONG LIFE AND ECONOMY

Offer Fuel Recovery Course

Rensselaer Polytechnic Institute announces the organization of its new department of fuel resources. Effective September, 1950, courses of instruction and research will be offered to candidates for graduate and undergraduate courses.

Subject matter covered in the new courses includes the occurrence, production, and recovery of fuels of all types, petroleum and gas, coal, oil shale, and fissionable materials. General studies in fuels will be embodied in courses of indoctrination. Students in other departments of the Institute may choose technical electives from the curriculum if they wish to orient their chosen fields toward the activities of the fuel industry.

During the spring term, 1950, two courses will be offered qualified students: Petroleum technology, a course of indoctrination for those entering the fields of oil and gas reserves; and applied geophysics, an introductory course in exploration for oil and gas by modern technological methods.

The department is headed by Dr. Roland F. Beers, nationally known geophysicist of Troy, New York, and Dallas, Texas.

Publishes Account of 14th Mid-Year Meeting

The American Petroleum Institute, Division of Refining, has published a book of addresses delivered at its fourteenth mid-year meeting in Houston, Texas, April 4 to 7, 1949. Addresses and papers are divided into 7 groups: Rapid methods of analysis, training, corrosion, vapor-lock problems, open dinner session, management of refinery maintenance, and disposal of refinery wastes.

The book, which contains 316 pages, is published by the Lord Baltimore Press, Baltimore, Maryland.

Butane May Be Used as Motor Fuel

Bus operators are examining the possibilities of butane as a motor fuel, as its cost is a fraction of gasoline and fuel oil, and it offers more than just price advantage, Bus Transportation, McGraw-Hill publication, has announced. When used as a motor fuel, butane provides almost complete combustion, resulting in virtual elimination of exhaust odor and crankcase oil dilution. Main disadvantages of butane are that special storage tanks, dispensing systems, and special carburetion are required.

McCarthy Chemical Plant Closed Down

The McCarthy Chemical plant at Winnie, Texas, has been shut down indefinitely for repairs. McCarthy Enterprises, one of the affiliated companies of Glenn McCarthy, announced repairing of the plant would involve additional engineering work. The plant has been closed temporarily twice before and has never reached full capacity operations, a spokesman stated. Production so far has been mainly methanol or methyl alcohol.

Sun Enlarges Toledo Refinery

Catalytic Construction Company has been awarded a contract by Sun Oil Company to double the capacity of the catalytic polymerization unit at the Toledo, Ohio refinery. The existing equipment, constructed in 1940, consisted of 24 reactors with a reserve structure area for the 24 cases to be added under the new contract. The existing cases and those to be installed are a type designed by the Sun Oil Company. The 48 cases will have a capacity of 5000 bbl per day of mixed butanes butylenes charge.

This added capacity will be required when the $20,000,000 refinery expansion in the Toledo plant is completed this spring. Catalytic Construction Company is also the contractor for this project, which features a quadruple reactor Houdriflow unit with a catalytic cracking capacity of 28,000 bbl per day.

NEWS

Imperial Oil to Build New Winnipeg Refinery

Imperial Oil Limited will build a refinery at Winnipeg of about 10,000 bbl per day capacity at a cost of roughly $10,000,000, G. L. Stewart, president, announced. The contract will be awarded shortly and completion of the project is scheduled for May, 1951. Increased refinery capacity together with movement of Alberta crude eastward by pipe line will mean lower petroleum product prices in the area served by the new facilities, the company said. The crude will be moved either by rail or branch pipe line from a take-off point on the Interprovincial line at Gretna, Manitoba.

Engineering studies for the new plant have been under way for some time and field work will begin as soon as weather conditions permit in the early spring. When in full operation the refinery will employ about 175 persons.

Non-Integrated Refiners Losing Money, Reports WPRA

Refiners who must buy all or most of the crude they process are losing money at an average rate of 17.11 cents per barrel processed, the Western Petroleum Refiners Association's latest survey shows. The results are based on an at-the-refinery price for crude of $2.79 per barrel, a refining expense of approximately 1 cent per gallon of crude, and about ½ cent per gallon selling and administrative expenses. Products distribution shows about 52.2 per cent to motor fuel of two grades and 11.4 per cent of distillate and furnace oils. The figures apply to plants ranging in capacity from 4000 to 8000 bbl per day of crude, situated in Kansas, Oklahoma, and North Texas. Prices used in the calculations were chosen from the minimum quotations in Platt's *Oilgram* and the *Chicago Journal of Commerce*. Below is given the tabulated data from which these findings were arrived.

	Per cent yield	Gallons	Price realization	Total
Gasoline ..Premium..	12.04	5.057	.10375	$ .5247
Gasoline ..Regular...	40.16	16.867	.09625	1.6234
Kerosine	2.4	1.008	.08250	.0832
No. 1 Distillate and Furnace Oil	9.6	4.032	.08000	.3226
No. 2 Distillate and Furnace Oil	11.4	4.788	.07375	.3531
Diesel	2.0	.840	.08000	.0672
Residual	16.6	6.972	.03214	.2241
Propane and Gases	2.0	.840	.05500	.0462
Loss	3.8	1.596		
Total	100.0	42.000		$3.2445
Cost of Crude F.O.B. Plant				$2.7900 per bbl.
Manufacturing Expense		.4196		
Administrative and Selling Expense		.2060		
			.6256	
Total			$3.4156	
Total Realization			3.2445	
Loss			$ .1711	

Grant 16 Fellowships

The Institute of Gas Technology has announced the availability of 16 two-year fellowship grants, effective September, 1950. They were awarded March 15. The fellowships are offered to prepare qualified young men for careers in the gas industry.

Phillips Oil Builds Venezuelan Refinery

Phillips Oil Company, wholly owned subsidiary of Phillips Petroleum Company, has agreed with the Venezulean government to construct and operate a modern refinery and wax plant in Eastern Venezuela in compliance with the terms of the company's oil concession contracts. This plant will manufacture over 2,000,000 lb of high grade wax per year. Actual construction is expected to begin in 1951, and should be in operation sometime in 1952.

The source of supply for the refinery and wax plant will be the company's production in its San Roque field situated on a 130,000 acre concession in the state of Anzoategui in Eastern Venezuela.

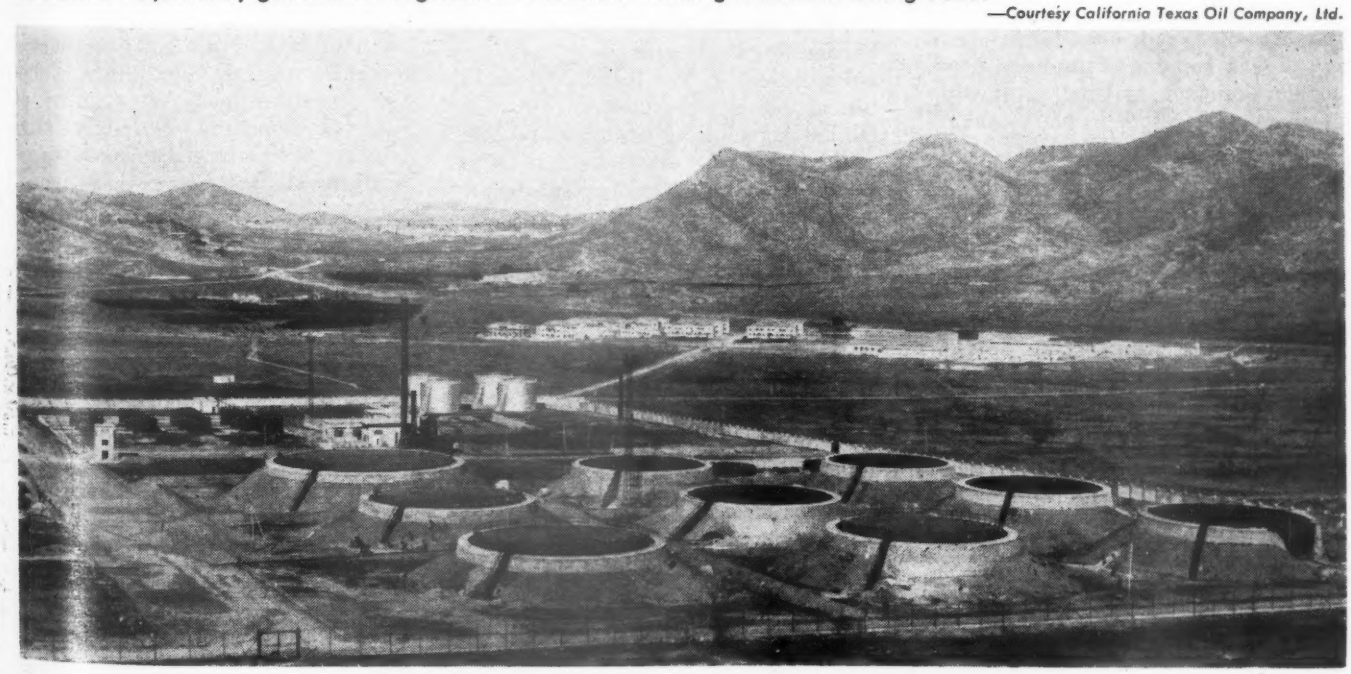
Pan American to Grant Graduate Fellowships

Pan American Refining Corporation has announced it will grant graduate study fellowships for the academic year 1950-1951. The fellowships, already accepted by the various institutions, are to be in the general fields of chemistry and chemical engineering. The Fellow should be within one year of completing his doctorate work.

Fellowships in Chemical Engineering are being continued at the University of Illinois, the Massachusetts Institute of Technology and Rice Institute. Chemistry fellowships are being continued at the University of Texas and University of Oklahoma.

View of new Spanish refinery at Cartagena. Gasoline and kerosine product tanks in foreground have walls and sand embankments required by government regulations. Personnel housing is seen in background.

—Courtesy California Texas Oil Company, Ltd.



—PERSONALS—

George B. Finley

George B. Finley, formerly of the Texas State Highway Department, has been named district engineer in charge of The Asphalt Institute office at Austin, Texas. There he will participate in the activities of the Southwestern division, comprising the States of Texas, Oklahoma, and New Mexico, under the supervision of Hugh A. Wallace, newly-promoted to the post of division engineer, whose office continues in the Southwestern Life Building, Dallas.

Dr. Charles W. Rippie has been made vice president of American Development Corporation, 201 East 57th Street, New York City, and will devote his activities to the development of the Gaylor gasoline treating-recovery process and similar methods, and in chemicals supply to the oil and other industries. Rippie is widely known in the oil and gas industries for his work in chemical treating of products, product development, and the application of chemical methods to petroleum refining. Dr. Rippie is a member of the Technical Panel of *The Petroleum Engineer.*

John G. Munson, who was field project engineer during the construction of Stanolind Oil and Gas Company's Brownsville chemical plant, has been named assistant plant superintendent at Brownsville. Before coming to Stanolind, Munson had 12 years' experience in engineering and chemical production with a leading manufacturer of synthetic resins and solvent chemicals. Since joining Stanolind in 1947, he has been continuously associated with the engineering and construction of the Brownsville plant.

Other men being transferred to the chemical plant staff are: **George R. Ayton, Joe C. Weaver, Jr., Lloyd Christensen, Raymond S. Tolson, Jr., George C. Merrick,** and **Max A. Meek.**

Ayton, formerly technical group group leader in the synthesis pilot plant at the Tulsa research laboratory, will supervise the chemical operations section at Brownsville. Weaver will be chemical process supervisor at the plant. He has been with Stanolind since 1947. Chemical plant laboratory operations will be supervised by Christensen. Before joining Stanolind in 1944, Christensen was a chemistry and physics instructor at Oklahoma A&M College in Stillwater, Oklahoma.

Merrick, who was industrial relations supervisor for Stanolind's Central division, will be industrial relations supervisor for the chemical plant. Safety and plant protection problems at the plant will be under the direction of Tolson, newly appointed plant protection supervisor. Tolson joined Stanolind in 1948 as a mechanical engineer. Meek, formerly senior accountant at the Tulsa general office, will head the plant accounting section. Meek has been a Stanolind employee since 1937.

These men, together with **L. L. Smith,** plant superintendent, will comprise the supervisory personnel at the Stanolind plant.

T. G. Stevenin, Deep Rock Oil Corporation, former chemical engineer of the U. S. Government's Northern Regional Research Laboratory at Peoria, Illinois, was named plant technologist, and **J. W. Beam,** formerly instrument engineer with Universal Oil Products was appointed supervisor of the instrument department at Deep Rock's Cushing, Oklahoma refinery.

Stevenin obtained his first BS degree in chemical engineering from the University of Kansas in 1939, and another in general agriculture from the University of Illinois in 1948. Following earlier experience in Standard Oil Company of Indiana's Whiting refinery, he served as process engineer for Phillips Petroleum at Bartlesville, Oklahoma.

Beam attended Georgia Tech, before receiving his BS degree in engineering from Purdue University in 1944. In 1945 he joined Universal Oil Products and became the company's chief field instrument engineer before joining Deep Rock.

Ward O. Longworthy, former assistant superintendent of Imperial Oil, Ltd.'s Regina refinery, has been appointed superintendent. He succeeds **Clifford R. Moore,** who retired recently. **William J. Beynon** succeeds Longworthy as assistant superintendent. Until his appointment, Beynon was assistant to the operations manager of the company's manufacturing department in Toronto.

Lloyd G. Alexander, formerly research assistant professor in the engineering experiment station of the University of Illinois, has been appointed assistant professor of chemical engineering at the University of Oklahoma. He will continue his study of the commercial production of derivatives of the lower paraffins, which he began in 1944 at Purdue University with an investigation of the vapor-phase nitration reaction.

E. M. Dons, Mid-Continent Petroleum Corporation, has assumed duties as general superintendent of manufacturing operations at the company's West Tulsa refinery. Dons joined the company as a draftsman in 1922, serving afterward as assistant general superintendent in charge of engineering, construction, and mechanical operations at the refinery.

Kenneth G. Jobson, manager, cylinder maintenance and testing department of The Linde Air Products Company, was elected president of the Compressed Gas Association at the annual meeting held at the Waldorf-Astoria Hotel in New York, January 23 and 24, 1950. He was educated at the King Edward VII School in Sheffield, England, and came to the United States in 1912.

H. W. Rigterink has been named general manager of the Solgas (liquefied petroleum gas) department of Sun Oil Company. Formerly sales manager of Solgas, Rigterink succeeds **William H. Bateman** who resigned. Bateman headed the Solgas organization for about 15 years, and has served as president of Martin and Schwartz, Inc. since 1938. Rigterink joined the Solgas organization as sales engineer in 1934 and became sales manager in 1944. He is chairman of the producers section of the Liquefied Petroleum Gas Association, and a graduate of Michigan State College.

Joseph C. Fletcher, chief engineer of Solgas since 1945, is the department's new sales manager. He started work at Sun Oil's Marcus Hook refinery in 1935, soon after receiving his degree in mechanical engineering at the Drexel Institute of Technology.

Bring on chemicals with TEETH!

"Karbate" Impervious Graphite tube-bundle heat exchanger, floating-end diaphragm construction, used for partial concentration of H_2SO_4 contaminated with volatile organics. Contains 233 tubes, ⅞ in. dia. by 9 feet long. Tube sheets are 28¾ in. dia. by 6¼ in. thick.

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Impervious Graphite Heat Exchangers ARE READY!

"Karbate" Impervious Graphite Heat Exchangers handle an extremely wide range of corrosive fluids. They are both acid-resistant and alkali-resistant. Their thermal conductivity is higher than that of most commonly used metals. They are light in weight, immune to thermal shock, will not contaminate the solution, and are amply strong and vibration resistant. "Karbate" heat-exchanger types include: tube-bundle, cascade, plate, bayonet, and concentric in standard and special sizes.

Other "Karbate" equipment includes: pipes and fittings, valves, pumps, tanks. For more details write to National Carbon Company, Inc., Dept. PE.

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NEWS

Sun to Double Poly Unit

Contract to double the capacity of the catalytic polymerization unit of Sun Oil Company at its Toledo, Ohio refinery has been let by the company to Catalytic Construction Company of Philadelphia. The old unit included 24 reactors and additional space in which the 24 new reactors are to be installed. The 48 cases will have a daily capacity for 5000 bbl per day of mixed-butanes-butylenes raw charge. The increased capacity will be required when the $20,000,000 expansion program at the Toledo plant, also under construction by Catalytic Construction, is completed this spring. This plan includes a 28,000 bbl per day quadruple reactor design of a Houdriflow catalytic cracking unit.

Plan Refining Patent Digest

Plans are going forward for a complete digest of refining patents to appear bi-weekly, according to Georgia Tech Experiment Station's Technical Information Division. Editor of this proposed service is B. H. Weil, chief of that information division, and for five years head of the Gulf Research and Development Corporation's chemistry division's information section.

The service will be supported proportionately by all cooperating refining companies; patents will be assembled, "truly definitive abstracts will be prepared," and reported to all concerned in bulletins issued 26 times per year. Abstracts will be placed on cards for those engaging that service, and all patents will be classified under suitable headings.

Standard to Build Gas Plant

Standard Oil Company of Texas is planning the immediate construction of a high pressure absorption type casinghead gas plant for the North Snyder Field. The plant will have an initial capacity of 30,000,000 cu ft per day. It is to be situated near the center of Standard Oil Company of Texas' acreage about seven miles north of the town of Snyder, Texas. Completion of the plant is scheduled for mid-year 1950.

LPG Course to Begin

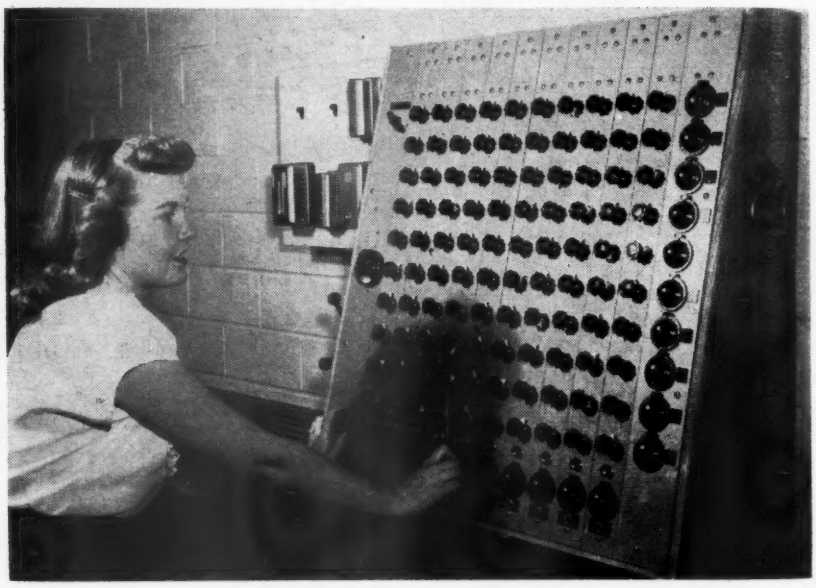
A new class in the streamlined gas fuel technology course designed to provide trained technicians for the liquefied petroleum gas industry, will begin March 27 at Southern Technical Institute, Chamblee, Georgia. The 18-month course was developed with the cooperation and technical counsel of Liquefied Petroleum Gas Association.

Phillips Petroleum Develops Electrical Computer

The Phillips 66 spectro computer, an accurate, time-saving, electrical computer that solves simultaneous linear equations of the type encountered in infrared and mass spectrometry, is now available from Phillips Petroleum Company.

This computer, which utilizes d-c electrical potentials substituted for the unknowns in the equations, solves these equations by a method of iteration. Multiplication, division, addition, and subtraction steps necessary in solving a spectroscopic analysis problem involving as many as 10 simultaneous equations can normally be performed by the computer within 5 to 30 min. Results of spectroscopic analysis of hydrocarbon samples have been computed to an accuracy of 0.1 per cent with this instrument.

Bulletin 278, describing this instrument and its uses in more detail, is available upon request to Phillips Petroleum Company, Special Products Division, Bartlesville, Oklahoma.



New electrical computer solves simultaneous linear equations.

New Charts Aid in Tower Design

Two large volumes of charts containing liquid-vapor equilibrium constants, and one large volume containing fugacities for light hydrocarbons in mixtures, have just been published by The M. W. Kellogg Company, refinery and chemical engineers of Jersey City, New Jersey.

The charts, based on the Kellogg Equation of State, cover pressures graduated from atmospheric to 1000 psia for any mixture of hydrocarbons from methane to n-heptane, including unsaturates. For higher pressures Kellogg has made available fugacity charts that go from 1000 to 3600 psia. Instructions for use and sample calculations for bubble points, dew points, equilibrium flash points are given.

The two volumes covering pressures from 14.7 to 1000 psia are available as a package for $20. An additional $10 will be charged for the volume of fugacity charts. For copies, write the Chemical Engineering Division, The M. W. Kellogg Company, 225 Broadway, New York 7, New York.

Report on Research Of Boiler Equipment

A revised procedure for determining the sulfur dioxide and sulfur trioxide in flue gases—one phase of Bureau of Mines research on boiler equipment—is described in a publication released by James Boyd, director.

In Bureau laboratories, the test procedure of the American Society of Mechanical Engineers was revised to prevent oxidation of sulfite in the absorption bottle and to allow for the effect of carbon dioxide. Analyses of flue gases produced satisfactory results. The volume contains four detailed tables on the various tests.

The publication, Report of Investigations 4618, "A Method of Test for SO_2 and SO_3 in Flue Gases," was prepared by A. A. Berk, Bureau supervising chemist, College Park, Maryland, and L. R. Burdick, Bureau supervising engineer, Washington, D. C. A free copy of the publication may be obtained from the Bureau of Mines, Publications Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

No "Economic Recession" Here

With talk of "economic recession" being bandied about in the manner of a shuttle in a badminton game, the pipe line industry can be pardoned if it should feel like taking a few bows. Such talk just doesn't seem to apply in this case. For, although during the last several years the pipe line industry has enjoyed its greatest period of expansion, and, in point of pipe mileage laid 1949 attained a new peak with approximately 15,000 miles, the year 1950 promises to surpass even 1949. This outlook is based on the fact that, although several long cross-country lines were constructed in 1949, even more are under way or announced for this year.

Last year the major projects were the Basin-Ozark Pipe Line Systems, the Michigan-Wisconsin Pipe Line Company, Texas Gas Transmission Corporation, and a part of Transcontinental Gas Pipe Line Corporation system. In the case of Transcontinental, 612 miles of the main line were laid last year. This system thus has 1228 miles for this year, plus several hundred miles of laterals.

Mid-Valley Pipeline Company, a 1000-mile crude oil line, just got under way in 1949 and will be completed this year. Texas Illinois Natural Gas Pipeline Company is expected to begin construction of its system from the Houston, Texas, area to Joliet, Illinois, and environs—1332 miles of pipe line. Northern Natural Gas Company has been granted permission to lay loop lines totaling 597 miles. A large part of Great Lakes Pipe Line Company's program, which calls for construction of 1450 miles of loops and extensions, will be done this year although a start was made in 1949.

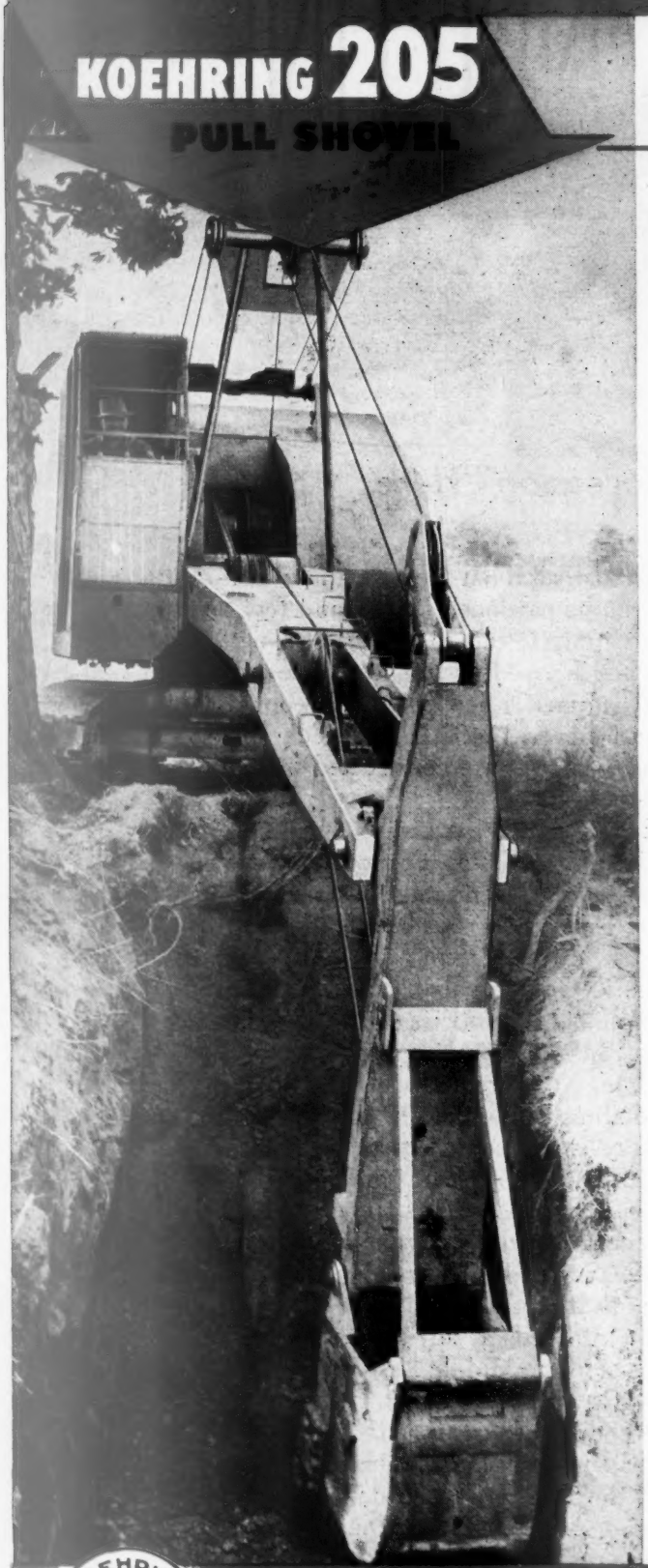
Southern Natural proposes to lay 803 miles of new lines, Interprovincial Pipe Line has a 1150-mile crude oil project under way, and Texas Eastern has requested FPC for permission to lay a total of 802 miles. Trunkline Gas Supply Company should get started on its 740-mile line from Louisiana to Illinois, and El Paso Natural is looping and building new lines that will total many hundreds of miles.

In foreign countries, brightest prospects are in the Middle East, where 5000 miles or more of pipe lines are to be laid, a part this year.

This mention is only of major projects under construction, those ready to start, or planned for the near future. Numerous smaller systems will be installed to swell the total mileage, and, of course, other plans will develop. In fact, it does not seem amiss to estimate that during the next three years approximately 40,000 miles of pipe lines will be constructed.

J. H. Love

HERE'S A POWERFUL PAIR OF TRENCHERS



NO WEAVING with this rigid pull shovel front end

Extra strength, extra resistance to side-sway are built into the Koehring ½-yard 205 pull shovel. You get a straight, clean ditch in toughest oil field digging because this 205 pull shovel is mounted on a rugged heavy crowd shovel boom. Front end will not weave . . . dipper doesn't turn away from the cut, because broad, shovel-type boom point gives a wide connection to the rigid pull shovel dipper arm. Its long, deep digging reach (15'3" below tracks), powerful ½-yard bite, fast swing and easy dumping mean more feet of pipeline trench per day.

dual-purpose boom saves time and money

Because pull shovel and crowd shovel use the same boom, this Koehring 205 combination saves time when you convert from one attachment to the other . . . and costs 20 to 25% less than conventional units that require two separate booms. What's more, crowd and retract cable is self-contained in boom, stays intact when boom is removed . . . saves more time when changing to dragline, clamshell, lift crane or pile driver.

Koehring heavy-duty 205 further assures more production at lower costs because you have independent traction, to travel, swing and operate boom all at same time . . . self-adjusting main clutches for peak operating efficiency at all times . . . choice of crawler, rubber-tired cruiser or truck mounting to suit your exact needs.

Your local Koehring distributor is experienced in oil field problems . . . will analyze your trenching, excavating and other materials-handling requirements in the interests of greatest efficiency, production and savings for *you*. See him today about Koehring heavy-duty ½-yd. 205 . . . ¾-yd. 304 . . . 1½-yd. 605 . . . or big 2½-yd. 1005.

KOEHRING HEAVY DUTY

KOEHRING COMPANY • MILWAUKEE 10, WISCONSIN

Subsidiaries: KWIK-MIX • PARSONS • JOHNSON

Coating and wrapping with traveling type equipment one of the recently constructed large-diameter pipe lines.

Oil Pipe Lines - A Look Into the Future

W. C. KINSOLVING

As the venerable old man was heard to say about the automobile, "I believe that pipe lines are here to stay."

Certainly the grim necessities of the recent war taught us that pipe lines can be laid anywhere. We are all familiar with the stories of the wartime pipe lines across the burning sands of Tunisia and North Africa; up the frozen wastes of the Alcan Highway into Whitehorse, Alaska; under the English Channel to the beachheads of Normandy in Operation Pluto; through the monsoon wastes of India, the jungles of north Burma, and over the humps of the Himalayas into China. All these and many more have proved that American stamina and ingenuity can lay pipe lines anywhere on this globe.

To evaluate properly the future of pipe lines, we must review the economic importance of this form of transportation. Nowhere has this importance been more strikingly displayed than in the recent developments in western Canada and Alberta.

A little over two years ago, discovery of oil was made at Leduc. At that time Alberta's estimated reserves were approximately 35,000,000 bbl. Within two years these reserves climbed to a billion barrels, and predictions are that quite a few billion barrels more will be added.

Alberta is far removed from the normal refining and consuming areas. Its refineries can handle only 60,000 to 65,000 bbl per day, whereas the existing wells are capable of producing more than double that amount at the maximum efficient rate of production. Outside of these local refineries, the nearest large refining center is Sarnia, Ontario, north of Detroit.

It has been estimated by an official of the Interprovincial Pipe Line Company that an all-rail movement from Edmonton, Alberta, to Sarnia, Ontario, would cost about $3.25 per bbl, whereas the pipe line tariff from the Mid-Continent area to Sarnia is approximately 50 cents per bbl. With the price of Mid-Continent crude at $2.65, this means that Sarnia can obtain oil from the southwest at approximately $3.15 per bbl. Even if the producer gave his oil away in Alberta and shipped it by rail to Sarnia, it could not compete with Mid-Continent crude.

The obvious answer to the problem

EXCLUSIVE

is a large diameter pipe line—which is now being built by the Interprovincial Pipe Line Company, a subsidiary of Imperial Oil, Ltd., of Canada. By promoting the development of oil production in Alberta, this one pipe line will increase the petroleum reserves of the Western Hemisphere, bring large sums of additional revenue to the Canadian government through new tax sources, and further the welfare of the citizens of the entire area.

This is an example of what pipe lines can do in the development of the health, wealth, and happiness of a nation, and it is demonstrated in many other instances both in this country and in foreign fields.

It is true that on a per barrel mile basis, pipe lines cannot compete with large modern ocean-going tankers. But when it is considered that pipe lines can run more or less directly between two points whereas tankers must follow the sea lanes, in many cases the pipe line is far more economical than the tanker. As examples, we have the pipe line from Portland, Maine, to Montreal, Canada, eliminating the long haul around Newfoundland and up the St. Lawrence River, and the various Trans-Arabian pipe lines from the Persian Gulf to the Mediterranean Sea, eliminating the long tanker haul around the Arabian Peninsula and through the high-toll Suez Canal. The lesson of the government's "Big Inch" and "Little Big Inch" taught us the feasibility of large diameter pipe lines. Already these lines of 24 in. and 20 in., respectively, are considered of somewhat medium size. The TAPline across Arabia is 30 in. and 31 in. and the new Iraq line is planned for 34 in. and 36 in. Today, any major pipe line extending from an area of large production to a main refining center is at least 20 in. in diam.

In order to accomplish the economies inherent in large lines, which range in capacity from 135,000 bbl per day upward, it is necessary to form combinations of substantial shippers. Very few shippers control or have need for such large amounts. To guarantee a steady load, it is necessary to form combinations of companies having community of interest in the areas of supply and demand. Such systems as the Basin, Ozark, and Mid-Valley are examples, and no doubt there will be others.

These are not combinations of monopolistic design, but combinations of economic necessity and efficiency. The companies joining in these ventures are highly competitive within the same areas. But to attract the relatively large capital needed for these lines, guaranteed steady daily loads of large amounts must be available. It is a well known fact that pipe line economies are only realized from high-load factors.

The ultimate economic result of these joint financial ventures and their engineering accomplishments is to give to the consumer the cheapest possible transportation and the benefit of the lowest possible market price. Thus, it should be obvious that pipe lines develop the welfare of the citizen of a producing area at one end and of the citizen consumer at the other end.

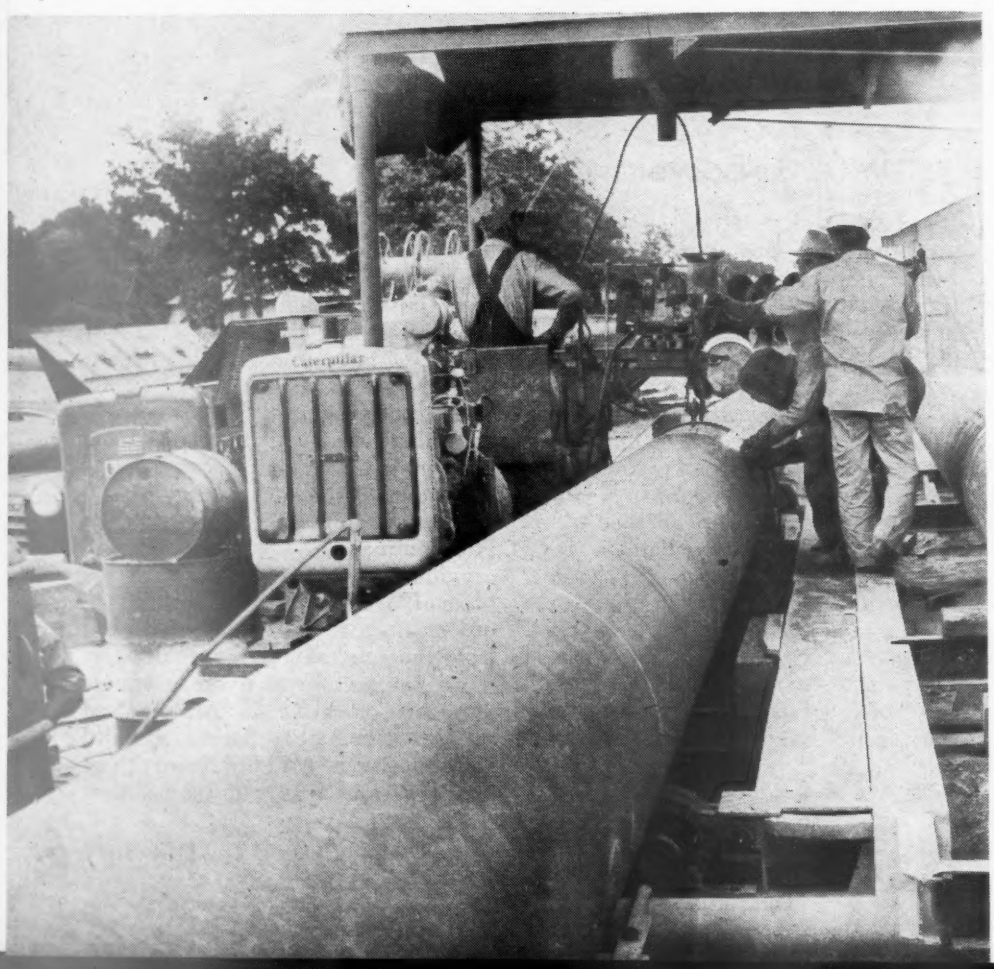
Pipe line statistics have been widely published, and there is no need to quote many of them. It is interesting, however, to note that since the end of the war the total mileage of crude, products, and natural gas pipe lines has increased by 60,000 miles through the year 1949. It is estimated that more than 12,000 miles of crude, products, and natural gas lines were completed in this country in 1949 and that approximately 2500 miles of foreign oil and gas lines were completed, making a total of nearly 15,000 miles.

New lines planned or now being

The Author

W. C. Kinsolving is president of the Sun Pipe Line Company (Texas), Susquehanna Pipe Line Company, and Mid-Valley Pipeline Company, the last a 1000-mile crude oil line now being laid from Longview, Texas, to Lima, Ohio. He joined the staff of Sun Oil Company immediately upon receiving a degree in electrical engineering from Cornell University. This was in 1923 and he was an ordinary oil-field hand. Advancing through various stages of oil-field work, eventually he was placed in charge of construction of a products pipe line in the East (1930-31). He then went to Texas to direct the construction and operation of a crude oil line from the newly discovered East Texas field to the Gulf Coast. In 1942 he was called to Washington to serve as assistant director of transportation for the Petroleum Administration for War. In this capacity he figured prominently in the planning and construction of the "Big Inch" and "Little Big Inch" pipe lines. Later he was commissioned a colonel in the Army Corps of Engineers and played a prominent role in the building of the China-Burma-India pipe line. Upon completion of his war service he returned to Sun as manager of all pipe line operations. Subsequently he was elevated to his present position.

Double-jointing of pipe in central yards using the submerged arc welding process is a comparatively new procedure.



built for 1950 and subsequent years total 27,000 miles for domestic projects and 5000 miles for foreign projects, making a total of 32,000 miles. Of course, all these probably will not be started in 1950 and some of them, such as gas lines, may be cancelled.

The fact that petroleum products pipe lines are still in their infancy and have only scratched the surface, coupled with the continued high demand for natural gas in the large industrial areas, indicates that the construction trend will continue for an indefinite time.

Engineering Developments

And now let us review some of the engineering developments that are making the pipe line expansion program possible, and see what the future holds for improved methods of construction and operation.

Techniques in laying large lines have undergone great changes in the short period since the laying of the war emergency lines in 1942-43. In comparison with the gang that operated as recently as ten years ago, one would hardly recognize today's big-inch spread with its large high-speed tractors, modern doping machines, half-track mobile units, mechanical bending machines, internal line-up clamps, and weld X-ray equipment.

Quite often some inconspicuous gadget, dreamed up by a pipe line spread foreman, has a remarkable effect. One of these is the present so-called internal line-up clamp. With the use of large diameter, thin wall pipe, it is very easy for the pipe ends to become slightly egg shaped or damaged in transit by the stringers. The internal line-up clamp, provided the pipe is not too badly out of shape, quickly and accurately brings the welding edges into perfect alignment, allowing the tack welders to stovepipe a joint at a rapid pace. With old fashioned external clamps, it is doubtful whether many of these joints could ever be lined up. This contributes a great deal to the speed of laying. Recently on a 20-in. spread of the Mid-Valley, using 20-in. by ¼-in. pipe, speeds of better than 10,000 ft per day of completed line were made.

The use of the new type bending machines, of which there are several on the market, has also materially aided in accurately bending pipe to fit the ditch.

The above two items are mentioned to show that some small idea often comes along that materially increases the laying capacity of a crew. There is no doubt that many more ideas are still to be developed.

It is only recently that pipe line engineers have appreciated the large savings in steel tonnage to be made by properly designing the wall thickness of pipe for the hydraulic gradient. Telescoping, or changing the wall thicknesses three times between stations is now customary practice, and large savings in steel are effected. Steel and pipe manufacturers are going to much higher tensile strengths and yields and lines are being designed for hydraulic strength without allowance for excess metal as a corrosion factor. This is only possible because of increased efficiencies of coatings and the development of expert knowledge on cathodic protection. In other words, good coating plus properly designed cathodic protection equals many tons of steel saved. The next step in this direction is for manufacturers to develop still higher tensile strengths and also some new form of factory applied skin coating.

Much remains to be learned concerning cathodic protection, especially with regard to the relative efficiency and economy between sacrificial anodes and rectifiers. In our experience we have found the former to have certain advantages.

There is also much to be done in raising the efficiencies of prime movers. The use of the diesel type engine, adaptable either to crude oil or a 10 per cent crude-90 per cent natural gas fuel, is now being used. This makes for a quick change-over from natural gas to crude oil. Much experimentation is being conducted on various types of pumps, both as to improved design and better efficiencies. Here, however, the centrifugal pump is still the accepted design for high capacity lines because of low first cost and low maintenance.

Too much cannot be said for the improvement in pipe line communications. The future of radio communication and control for pipe lines is almost fantastic. By means of the beam type micro-wave radio, it is now possible to install a system that can carry up to 32 circuits along the beam. These circuits can be made to accomplish any service that can be done with metallic wires. You may have voice, teletype, remote control circuits, telemetering circuits, and an almost unlimited number of other uses.

In micro-wave radio, a relatively narrow beam is directed along the route of the pipe line, with a beam width of approximately 3½ to 5 deg. As the transmission is in line of sight, towers must be erected at proper intervals to take care of the curvature of the earth and irregularites of the terrain. On an average, tower spacing

A high-speed buldozer being used to clear right-of-way on a big-inch pipe line construction spread.

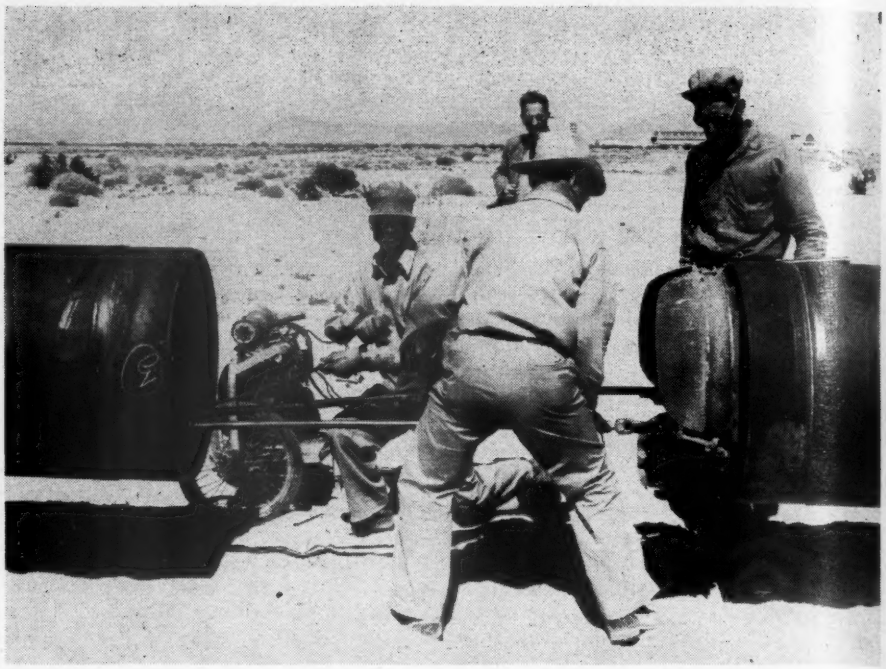
would be about 30 miles, although a great deal depends upon the terrain. These towers range from 120 to 175 ft in height.

It is quite expensive to use the full 32 channels available in a micro-wave system. In order to keep the cost comparable to that of a two-wire metallic circuit telephone system, the channels would probably have to be limited to about eight. If this standard is followed, such a system can be installed for little more than a standard two-wire telephone line. The maintenance charges, however, are only a fraction of those of a telephone line and the service is many times better. Troubles such as ice-laden lines, trees and other obstacles, and malicious damaging of telephone lines are eliminated. Micro-wave circuits are also practically static free and, being of narrow beam, are more or less private. In addition, the availability of wave length assignments from the Federal Communications Commission is infinitely greater than the already crowded wave lengths of ordinary type radio.

The micro-radio is implemented by an installation of very high frequency (VHF) stations to establish contact with mobile units in superintendents' and maintenance cars and patrol planes. When it is seen that all these advantages can be had for almost the price of a telephone circuit, without the headaches of telephone maintenance, it is understandable why radio has, and should continue to have, great popularity in the field of pipe line communications.

Line of the Future

And now, in this day of atomic energy, radar, and supersonic rockets to the moon, let us imagine what a pipe line system might look like in the not too distant future:



The internal line-up clamp is now in universal use on large-diameter pipe and is recognized as essential to speed in welding operations.

Our hypothetical line is 1500 miles long, of 36 in. diam and capable of handling 500,000 bbl per day or better. Its pump stations are approximately 200 miles apart. Except for terminal points, a main line pump station consists of completely automatically controlled prime movers and pumps with electrically operated valves. They are buried in the ground in an adequately ventilated pit, so that all that appears at the surface is a grate or metal cover, or perhaps they are above ground but without buildings. No one is in attendance except a watchman or caretaker.

The line of the future is completely controlled by radio and the chief dispatcher sits in a large office completely surrounded by control boards, one for each station. On this board are all the customary pressure gauges and flowmeters now installed in stations. Other gauges are used for recording tank gauges, and by means of radio circuits this one room is able to start and stop all stations, handle all gate valves, gauge all tanks, dispatch and handle all batches, and immediately locate trouble that might cause the shutdown of a station. If trouble develops in one station, the master controller immediately finds the cause of it by a system of radio control. If it requires attention, the dispatcher calls the nearest mobile unit and sends it to the point of trouble, in the meantime bypassing this station. He is in constant contact with his air patrol, and the air patrol is in contact with both the dispatcher and the ground maintenance forces.

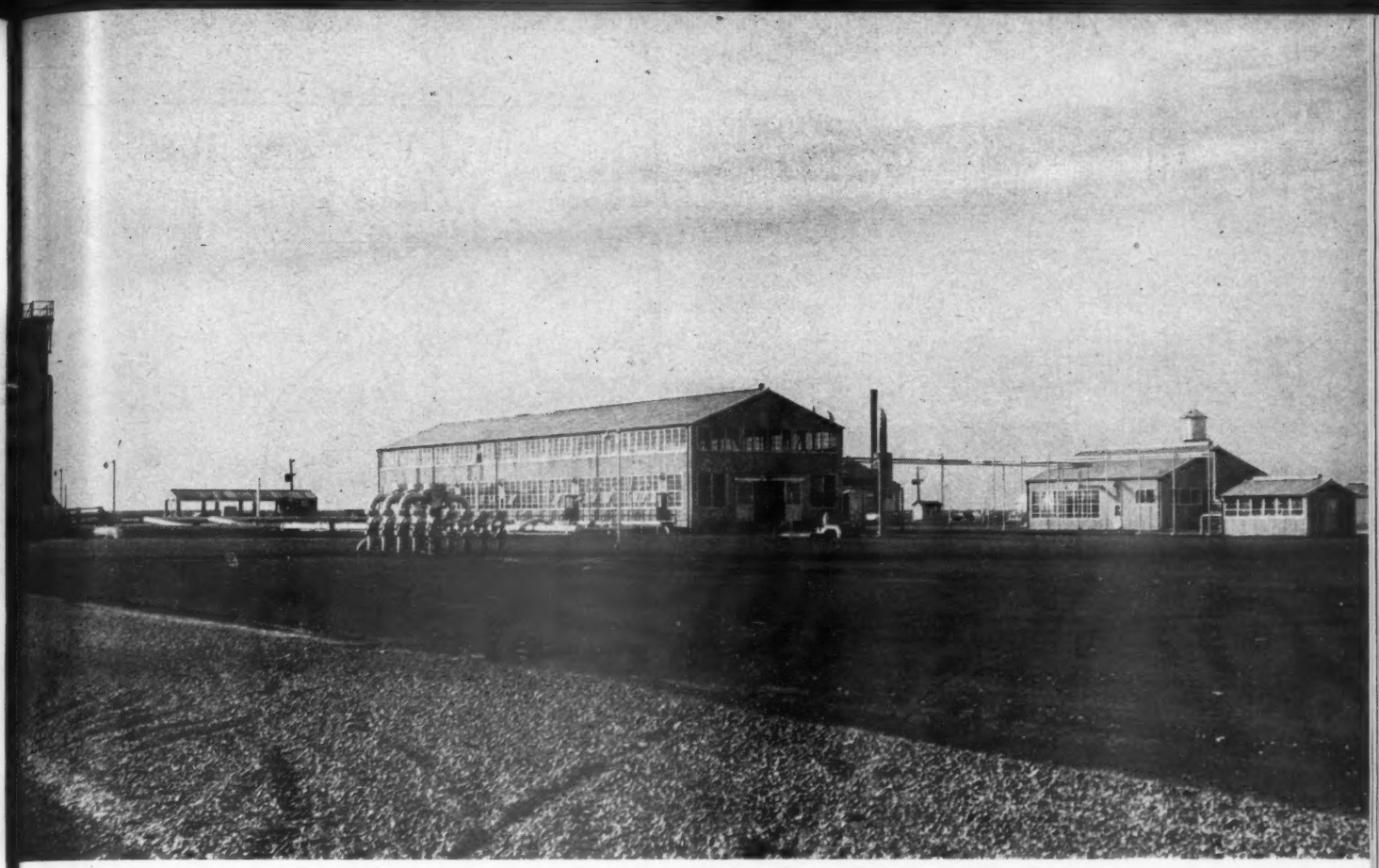
All forms of protective devices, such as over-pressure and under-pressure relay cutouts, hot bearing relays, hot motor winding relays, and high water-jacket temperatures, fully protect the station and register back to the master controller. All that is needed is an occasional visit from the division supervisor. In other words, it is completely a push-button pipe line.

Don't call it a far off dream. Devices are available today that could make possible this line of the future. * * *

Stopping a Centrifugal Pump Noise

In the writer's city there was a noisy centrifugal pump that operated with a suction lift. The engineer asked whether it would be all right to admit air into the suction.

Air admitted into a suction line sometimes does eliminate noise, but the writer does not recommend this procedure. The noise is sometimes due to the fact that the suction lift is excessive, causing what is known as "cavitation" in the impeller. Air in the suction is generally *bad* because it reduces pump efficiency and it is also likely to promote corrosion. In other words, admission of air into the suction is a makeshift method. The preferable way is to determine the cause of the noise and then eliminate it. If the noise is due to excessive suction lift the pump can probably be lowered sufficiently so that the lift will be of correct height. Do the bearings rattle? If so, repair the bearings. There always is a *best* way to handle a repair job.—W.F.S.



Partial view of the field station, situated in Hansford County, Texas.

P 623.

Michigan-Wisconsin Line a Major Project

FRANK H. LOVE*

ONE of the outstanding new pipe line systems to be placed in operation during recent months is that of the Michigan-Wisconsin Pipe Line Company, which extends from the Texas Panhandle area to distribution points in Michigan and Wisconsin.

The 24-in. main line originates at a field compressor station and dehydration plant in the Hugoton field, Hansford County, Texas, approximately 12½ miles south of Guymon, Oklahoma. From that point it extends in a northeast direction 796 miles to Wisconsin Junction, about 4 miles southeast of Sandwich, Illinois. The main line then continues as a 22-in. extending eastward around Lake Michigan 256 miles to the Austin storage field, about 6 miles southeast of Big Rapids, Michigan. From Wisconsin Junction, also, a 22-in. lateral extends northward 105½ miles to Milwaukee, Wisconsin. Lateral lines off the 24-in. line include 5 miles of 2 and 3-in. to Maryville, Missouri; 2 miles of 2-in. to Mt. Pleasant, Iowa, and 56 miles of 3, 4, and 6-in. to Keokuk, Burlington, and Ft. Madison, Iowa. Laterals in Wisconsin off the 22-in. to Milwaukee include 62 miles of 10-in. to Janesville and Madison with 12½ miles of 4-in. to Beloit and 2 miles of 2-in. to Stoughton, and 20 miles of 10-in. to Racine. These lines were all completed in 1949. Certain laterals in Wisconsin are to be constructed this year. From a point on the 22-in. line to Milwaukee, a 10, 12, and 14-in. line will be laid northward to Green Bay with laterals to serve Fond du Lac, Oshkosh, Appleton, Sheboygan, Manitowoc, and Two Rivers.

EXCLUSIVE

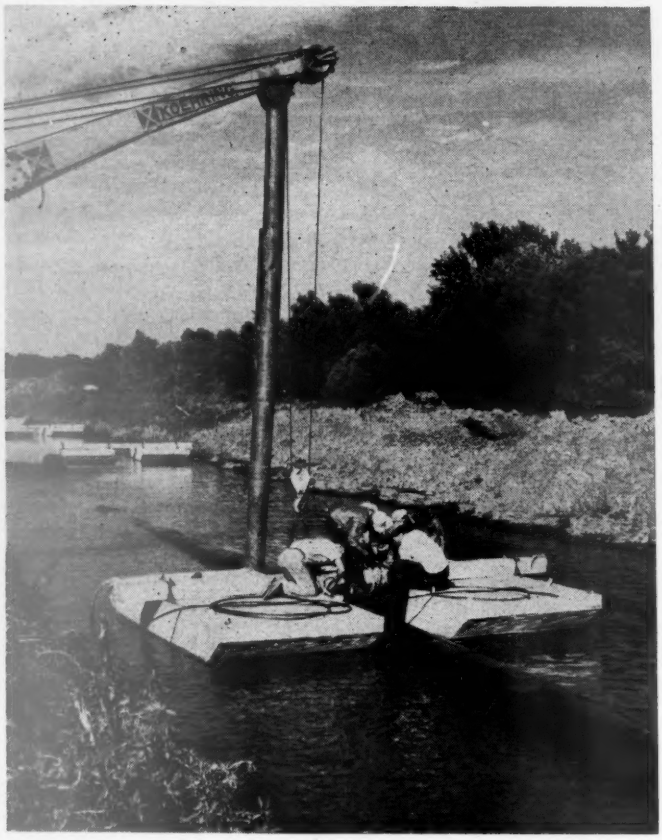
Main line and laterals total 1317 miles of pipe line. The 24-in. main line is being operated at a pressure of 970 psig and the 22-in. line at 850 psig. Phillips Petroleum Company has dedicated to the pipe line company 655,420 acres in Texas County, Oklahoma, and Sherman and Hansford Counties, Texas. For the initial stage of operation 155,000,000 cu ft of gas is being withdrawn daily. A proposed stage calls for 303,000,000 cu ft a day sales.

Construction

Laying of the 24-in. main line was begun by the J. R. Horrigan Construction Company, Inc., of Houston, Texas, on December 10, 1947, as part of the 272 miles of Spread No. 1. This spread was shut down from March 1 to June 1, 1948, and when work was resumed the contractor also started Spread No. 2 with 79 miles and Spread

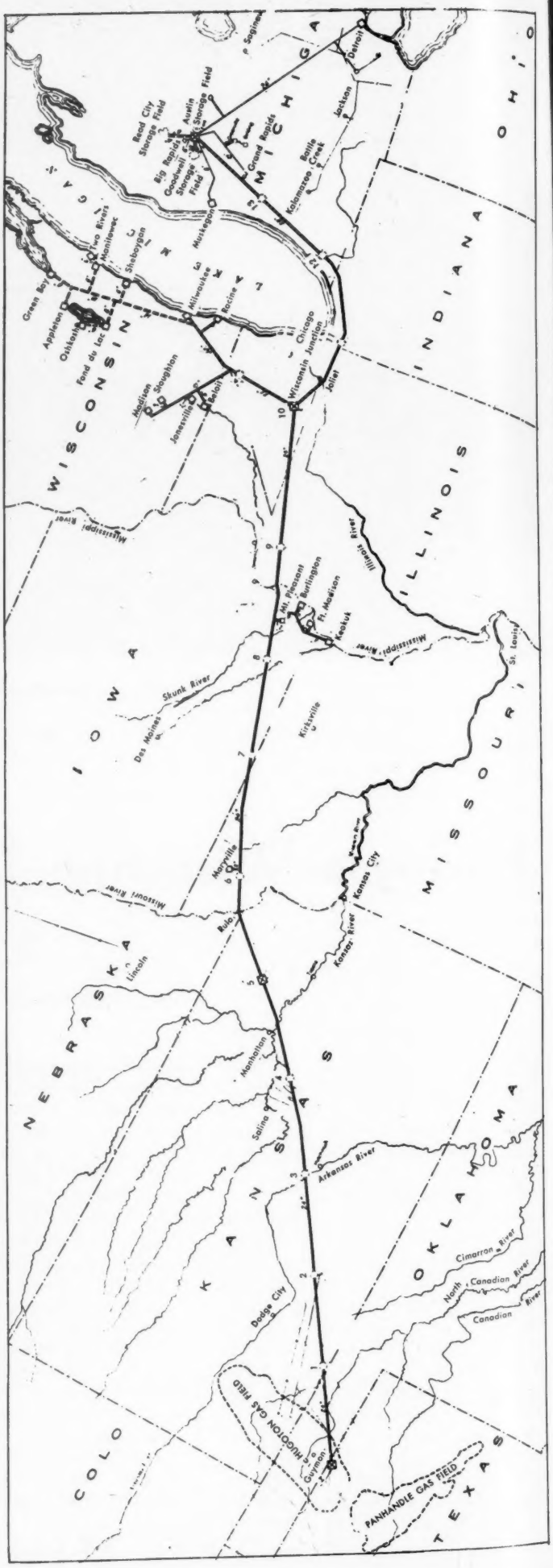
*Editor, *Oil and Gas Pipelining.*

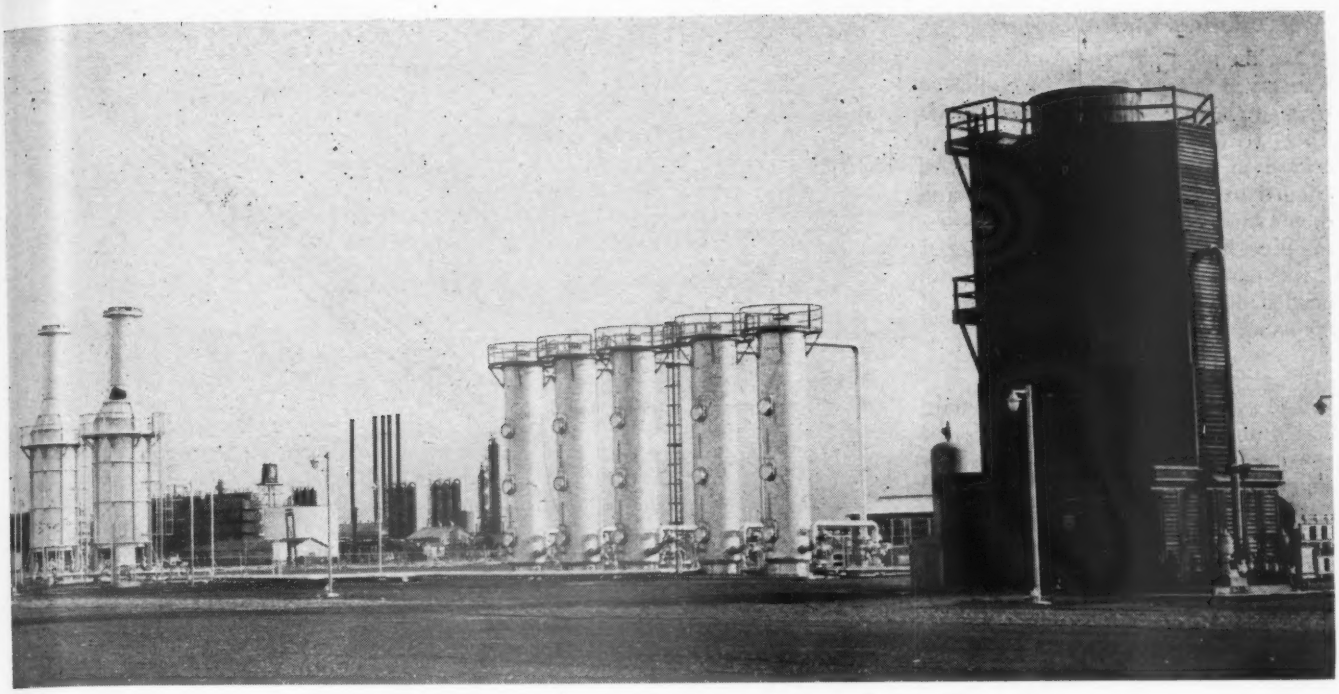
Right, system map of Michigan-Wisconsin Pipe Line Company



In making the Mississippi River crossing pipe was suspended in the water from pontoons.

Boring a highway crossing. All hard surfaced highways were bored and the line pipe cased.





Dehydration plant at the field station, Hansford County, Texas.

No. 3 with 103 miles. This part of the main line was completed in January, 1949, and brought the line up to Maryville, Missouri, a distance of 455 miles from its origin.

While this work was in progress various river crossings were being installed. R. H. Fulton and Company of Lubbock, Texas, completed the Beaver River crossing in Oklahoma and Cimarron River crossing in Kansas. C. S. Foreman of Kansas City completed the Arkansas River and Kansas River crossings in Kansas. Other river crossings in the first 455 miles of main line were installed by Horrigan as extra work along with the pipe line spreads.

These river crossings are single-line submerged 24-in. lines with the exception of the Missouri River crossing at Rulo, Nebraska, which is a single 24-in. line suspended on a highway bridge. Open trench dragline excavation was employed in making these crossings, and the Beaver, Cimarron, and Arkansas rivers were de-watered using the well-point system.

Construction of the 24-in. main line from Maryville to Wisconsin Junction was begun in March, 1949, by J. R. Horrigan. With two spreads this 340 miles of line was completed in October. Also constructed during the year were the Des Moines and Skunk river crossings in Iowa. Both are single-line submerged 24-in. crossings. They were installed by C. S. Foreman Company. The Mississippi River crossing was installed 2 miles south of New Boston, Illinois, by the Omaha Dredge and Dock Company of Omaha, Nebraska, and consists of dual submerged lines. All other single-line submerged crossings in the section from Maryville to Wisconsin Junction were constructed by Horrigan as a part of two spreads.

The 256 miles of 22-in. main line from Wisconsin Junction to the Austin storage field was contracted by J. R. Horrigan. Oklahoma Contracting Company, as sub-contractors for Horrigan, began construction in March, 1949, at the Austin field end and completed 198 miles through Michigan and Indiana to the Illinois line in October of that year. The 58-mile section in Illinois was begun in August and finished in October. All river crossings were single-line submerged and were installed as part of the pipe line spreads.

The Wisconsin 22-in. lateral was laid between March and August, 1949. Of this 3½ miles is considered as a lateral line to Milwaukee and 102 miles is a trunk line to serve other facilities north of Milwaukee. This line also was laid by Horrigan.

The 2 and 3-in. laterals for Maryville, Missouri, were constructed by Horrigan, and the 58 miles of laterals in Iowa were constructed by Rumsey Brothers Pipe Line Construction Company of Wichita, Kansas.

The laterals in Wisconsin to Janesville, Madison, Beloit, Stoughton, and Racine were constructed by two spreads of Anderson Brothers Corporation of Houston, Texas. This job, as well as that by Rumsey Brothers, was completed early in November, 1949.

The Wisconsin laterals north of Milwaukee, construction of which is expected to begin about April 1, have been contracted to G. G. Griffis Construction Company of Tulsa, Okla. They consist of approximately 42½ miles of 14-in., 21 miles of 12-in., 54 miles of 10-in., 35 miles of 8-in., 22 miles of 6-in., and 10 miles of 4-in. With three spreads being used it is expected that this work will be completed in June.

Ford, Bacon, and Davis, engineers, is acting as agent for the Michigan-Wisconsin Pipe Line Company in the construction of this system. As a part of its functions, this company did all design work, drafting, mapping, surveying, right-of-way procurement, and settlement of construction damages. For the purpose offices were installed in Kansas City, Missouri.

Details are given in the following paragraphs of the design and construction of the system, including compressor stations.

Line Pipe

The 24-in. OD pipe used in the system has a wall thickness of $\frac{11}{16}$ in., $\frac{1}{2}$ in., $\frac{5}{16}$ in., and $\frac{1}{2}$ in., depending upon the service in which it was used. This diameter pipe has a minimum yield point of 52,000 lb and maximum tensile strength of 70,000-72,000 lb. Wall thickness of the 22-in. pipe is ¼-in. and $\frac{5}{16}$ in. Minimum yield point is 52,000 lb and maximum tensile strength 72,000 lb.

Coating and Wrapping

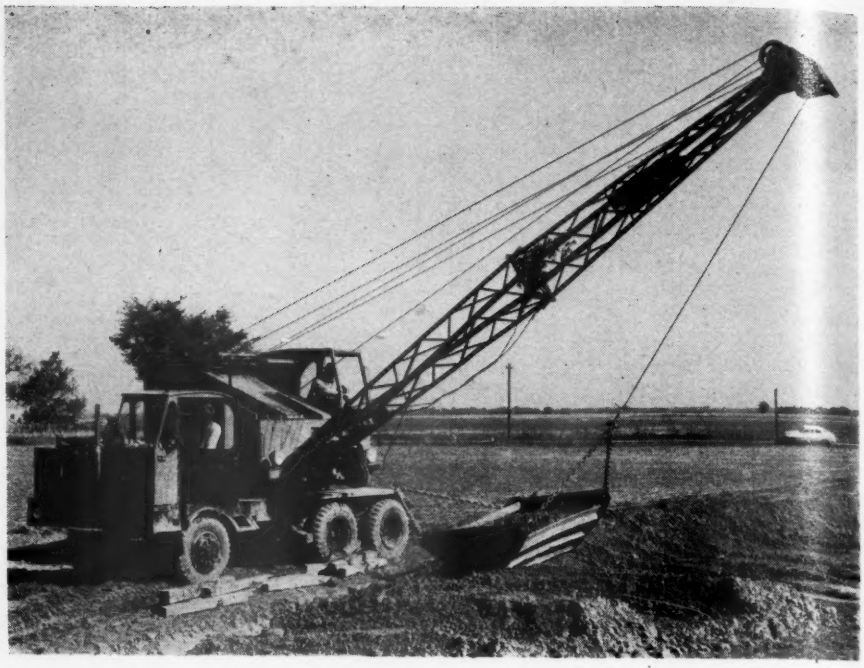
For the most part the main line pipe was given a coat of primer, followed by a single coat of enamel, and a glass fiber wrapper. River crossings received in addition a second coat of enamel over the fiber glass wrap and then a final wrapping with 15-lb asbestos pipe line felt. Also, in Division 1 it was decided that a wrapper was not needed on about 75 miles because of the sandy condition of the soil.

Main Line Valves

The system is equipped with main line lubricated plug valves of the worm gear operated venturi type, installed at an average spacing of 15 miles. The valves have gas-actuated automatic closing cylinders that operate on sudden pressure drop conditions.

Highway, Railroad Crossings

Throughout the system an especially large number of highway and railroad crossings was made, although perhaps not excessive when the number of miles covered by the line is considered. Approximately 227 highways and 92 railroads were crossed by the main line system, 60 highways and 13 railroads by the Milwaukee lateral, and 16 highways and 8 railroads by the Iowa laterals. All hard surfaced highways and railroads were bored and the 24-in. pipe was cased in 30-in. steel pipe and the 22-in. with 26-in. pipe. Casings were closed at each end and vented as required by the various states and railroad authorities. County highways and side roads were ditched when permissible and cased and vented when required. Welding sleeves were used on all cased crossings, both highway and railroad, and on river crossings.

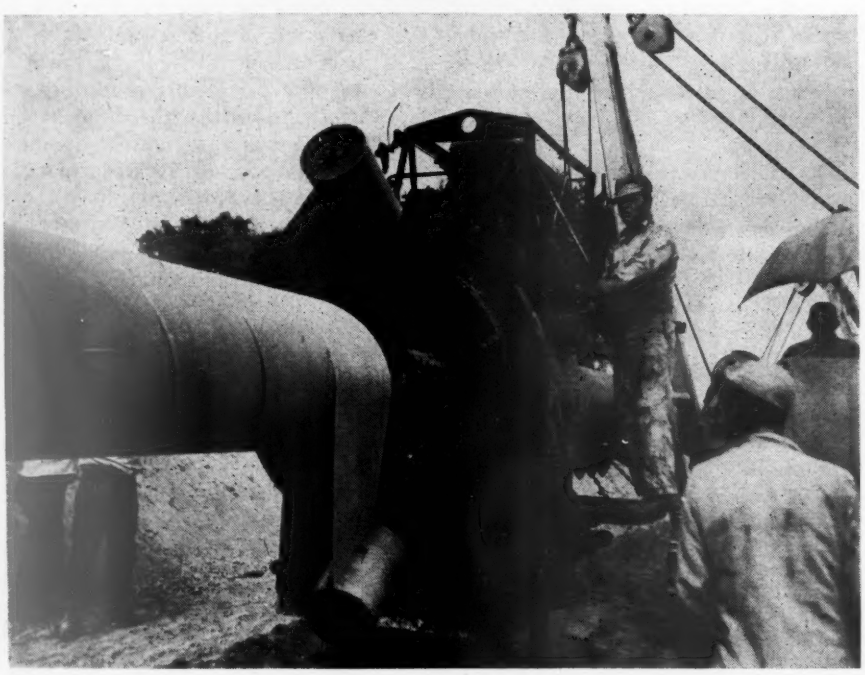


A special board being used to backfill the ditch after pipe had been lowered in.

Cathodic Protection

Cathodic protection will be provided on all portions of the line when a subsequent survey indicates it is needed. During construction, however, test leads were installed for the purpose of checking the soundness of the coating, and these can be used at a later date for the installation of cathodic protection, if and when needed. The test leads consist of No. 8 copper wire attached to the line pipe and brought to the surface through 2-in. pipe filled with enamel for protection and capped with a screwed pipe cap. After the backfill had settled for several weeks a special type of holiday detector was attached to the leads, which determined whether flaws had developed in the coating subsequent to its having been tested by another type of holiday detector immediately after being coated and before being lowered in. The test leads are spaced from 3000 ft to a mile apart and are located on the downstream side of road crossings whenever possible.

Coating and wrapping the pipe.



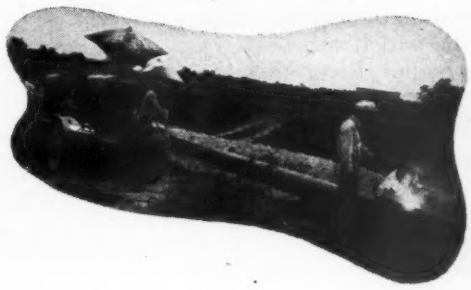
Communication System

The communication system consists of a single line talking circuit leased from the American Bell Telephone and Telegraph Company. There is a PBX termination at the company's main office in Detroit and a standard telephone termination at each of the compressor stations, and the company's offices in Big Rapids and Grand Rapids, Michigan, Sterling, Kansas, Fairfield, Ohio, and Waukesha, Wisconsin. There is also local telephone service at each of these points.

River Crossings

In discussing this pipe line system, more than brief mention should be made of the river crossings. A total of

Pipeline Know-how



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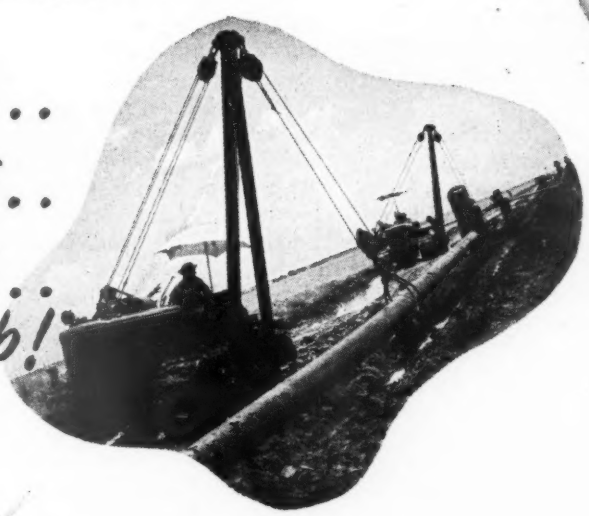

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13 important rivers were crossed and three types of installations were used to span them. On the minor and less hazardous streams, a single submerged crossing was made using 24-in. OD, $\frac{5}{16}$-in. wall pipe. On some of the narrower but more hazardous rivers, such as the Beaver, Cimarron, Arkansas, Kansas, Nemaha, Nodaway, and One Hundred Two, single 24-in. crossings were made but the wall thickness of the pipe was increased to $\frac{1}{2}$-in. At Rulo, Nebraska, a single 24-in. line was suspended on the highway bridge across the Missouri River. In the case of the Mississippi River dual submerged lines were laid of 24-in OD, $\frac{11}{16}$-in. wall pipe.

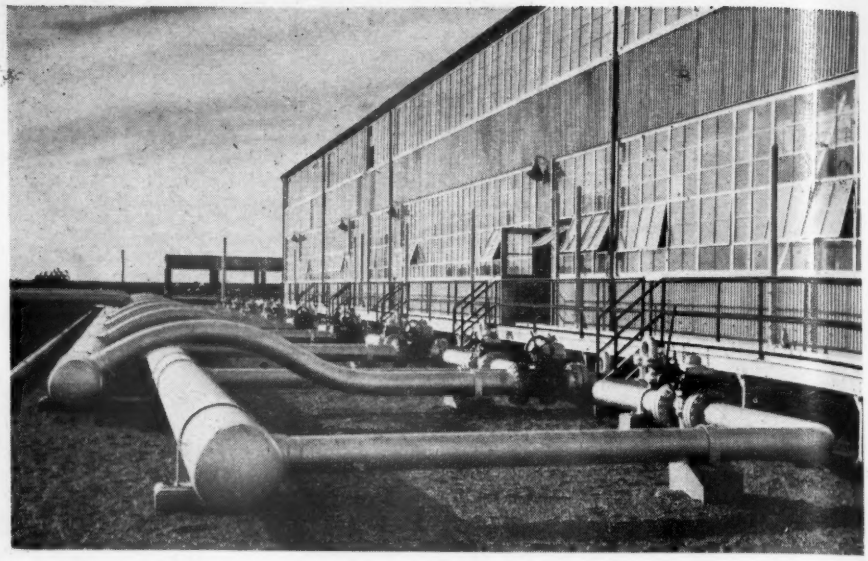
Mississippi River Crossing. One of the special crossings was that of the Mississippi River. This installation is at a point near New Boston, Illinois. and is partly in Louisa County, Iowa, and partly in Mercer County, Illinois. Dual submerged 24-in. lines were laid. A total of 120 calendar days was required for this project during which period there were 7 days lost due to rain. In all, 7524 ft of earth trench was made, 3000 ft with draglines. In the river bed a dredge with a 12-in. suction and 10-in. discharge, plus a 2-yd dragline, was used for excavation of the ditch.

On the west side of the river, from the toe of the levee to the beginning point of the river construction on both lines, the ditch averaged 6 ft wide at the top with a 3-ft width at the bottom and a 5-ft depth. From the inside toe of the west levee to the water's edge, a channel was ditched to a minimum of 25 ft wide at the top and an average of 4 ft at the bottom, with a depth of 5 ft directly east of the levee, increasing to a depth of 25 ft at the water's edge.

In the river bed the trench was dredged approximately 14 ft wide at the top, with a 4-ft average at the bottom, and a minimum depth of 7 ft 6 in.

On the east side of the river at the water's edge the trench was excavated approximately 25 ft wide at the top with the bottom dimension averaging 4 ft, and the depth 20 ft. As the trench approached the levee these dimensions increased. Directly west of the inside toe of the levee the trench was approximately 6 ft wide at the top, with a 4-ft average width at the bottom, and a depth of 4 ft. From the outside toe of the levee, running east to the end of both lines, the ditch was approximately 5 ft wide at the top, 3 ft wide at the bottom, and 5 ft deep.

The levees on each side of the river were not graded or trenched. The river crossing lines come to the surface of the original ground at the base of each levee, cross over the levee on its surface, and re-enter the ground at its other base. After the lines were constructed in this manner, dirt was packed in and around the sides and top of the pipe, giving it a minimum cover of 18 in.



Suction and discharge headers at the field station, Hansford County.

As mentioned, the pipe was of 24-in. OD and the ends were beveled 45-50 deg for welding. The Shield Arc Process was used in welding all joints. Fleetweld $\frac{5}{32}$-in. No. 5 rod was used for the stringer bead, with $\frac{5}{32}$-in. No. 85 for the first three hot passes and filler. For the top filler $\frac{3}{16}$-in. No. 85 rod was used and the cap weld was put on with $\frac{3}{16}$-in. No. 5 rod. Reinforcing sleeves were installed over welded joints, and 3000-lb cast-iron river weights were spaced at 48-ft intervals. Before installing the clamps the pipe was wrapped with asbestos felt to protect the coating.

Coating specifications called for a primer paint, a $\frac{3}{32}$-in. coating of enamel with an allowable negative tolerance of $\frac{1}{32}$-in., and a second coating of enamel applied to a minimum thickness of $\frac{1}{16}$-in. With the first coating a glass fiber wrapper was applied, and with the second coating 15-lb asbestos pipe line felt. Coating and wrapper were applied on shore except for overbends, sags, and spaces left at the welding sleeves.

After the pipe was coated and wrapped, a holiday detector was used to detect any possible voids. After running the detector, $\frac{3}{16}$-in. thick preformed asphalt-impregnated fiber felt was secured about the pipe with pressed paper bands to provide protection for the coating during installation. They were spaced at 3-ft intervals.

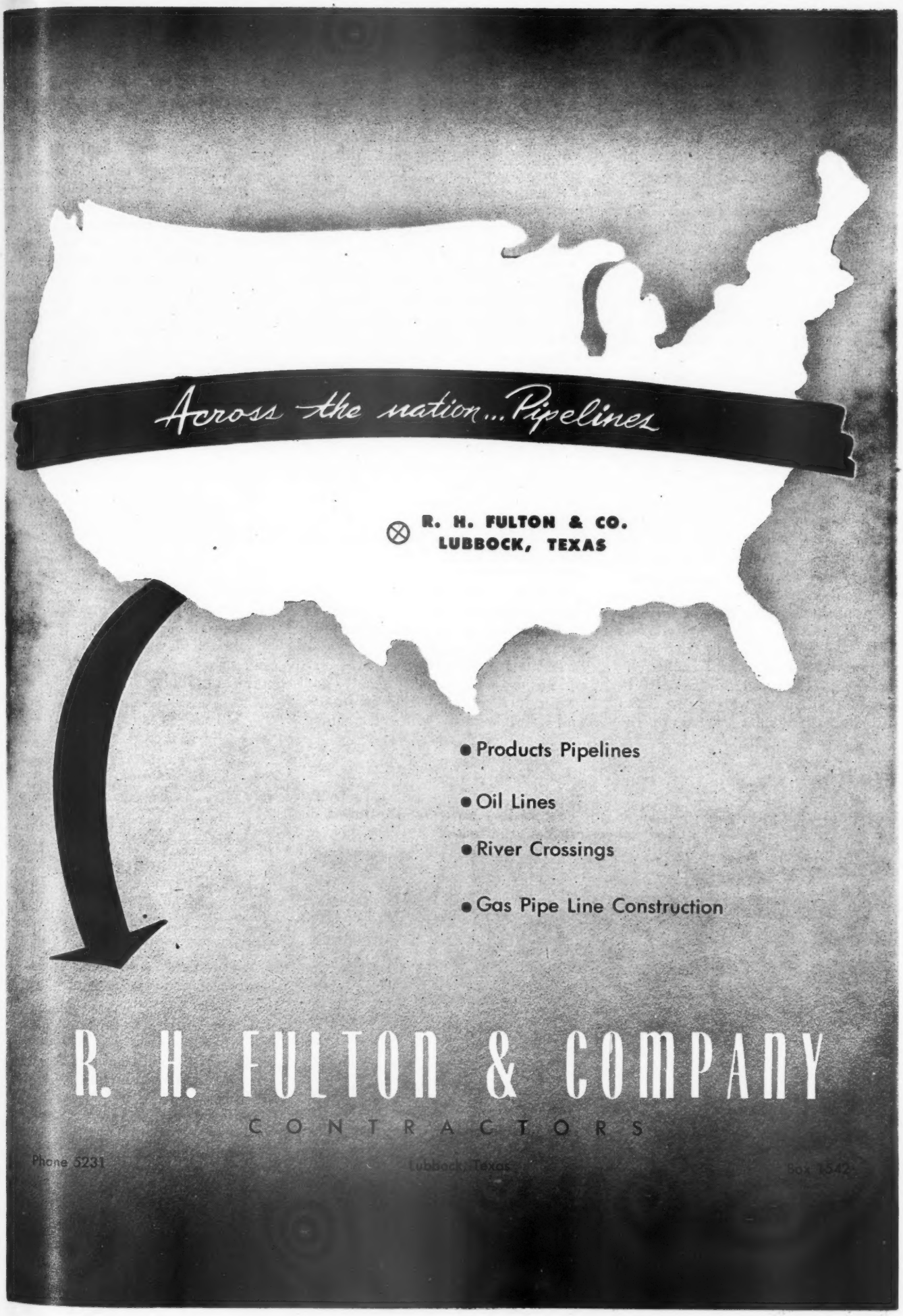
The pipe on both the south and north lines was prepared for installation in six sections each. The section of pipe used in the river bed proper was prepared in one section on the west side of the river, then placed in the channel, which was excavated from the water's edge to the west levee. The pipe was suspended in the water from pontoons placed at intervals of approximately 150 ft. At the points on the pipe supported by the pontoons, wooden slats were installed around the pipe to give protection to the coating. The pipe was then pulled into place with the use of winches pulling from the east side of the river. After the pipe was in proper position, it was gradually lowered into the river bed ditch, except for the east and west ends, which were left supported for the tie-ins.

The river bed was backfilled with the 10-in. dredge and a 2-yd dragline by taking soil from the downstream side and placing it in the trench.

To prevent erosion and stabilize the bank, 400 tons of limestone rock were used on the east side of the river for rip-rapping. The rock was rip-rapped upward with a gradual taper to the top of the bank. No rip-rapping or sacking was installed on the west bank of the river, as the sand-cement conglomerate used to restore this bank to its original profile was considered adequate.

As a preliminary test, four separate sections of the pipe were subjected to hydrostatic pressure of 1050 psig prior to their installation. The sections tested included only the pipe laid between the west and east levees on both the south and north lines.

The south line was "pigged" and blown using the north line as a reser-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voir. The north line was then "pigged" and blown using the south line as a reservoir. In both instances 100 psig air pressure was used. The crossing was purged with natural gas at the same time as the main line.

As a final test, natural gas pressure of 805 psig was placed on the north line and also on both 16-in. cross-over lines. The section was then closed in and a test made with a dead weight gauge for a period of 12 hr. The south line was similarly tested, except that in this instance the natural gas pressure was 1040 psig.

Two main line valve assemblies were installed on the crossing, both on the south line. In both instances the assembly consisted of two 6-in. blow-off valves. Two side valve assemblies also were installed, one on each of the 16-in. crossovers.

Des Moines River Crossing. Another important river crossing was that of the Des Moines in Van Buren County, Iowa, six miles from Eldon. This crossing was made in 96 calendar days. It required a maximum cut of 10 ft on each bank. One-hundred and sixty-six feet of dirt trench was involved, the trench being excavated with draglines to a minimum width of 48-in. at the top and 36-in. at bottom.

This river had a rock bottom and 602 ft of solid limestone had to be blasted. The rock was removed by drilling 6-in. holes to a depth of 10 ft, spaced 6 ft apart, which were filled with 40 per cent gelatin dynamite. The river bed was shot in three sections, the first section requiring 38 shot holes, the second 41 holes, and the third 31.

Pipe joints were electrically welded using $\frac{1}{8}$-in. No. 5 rod for the stringer bead, No. 85 rod for the filler, and No. 5 rod for the cap weld. All wells on this crossing were X-rayed.

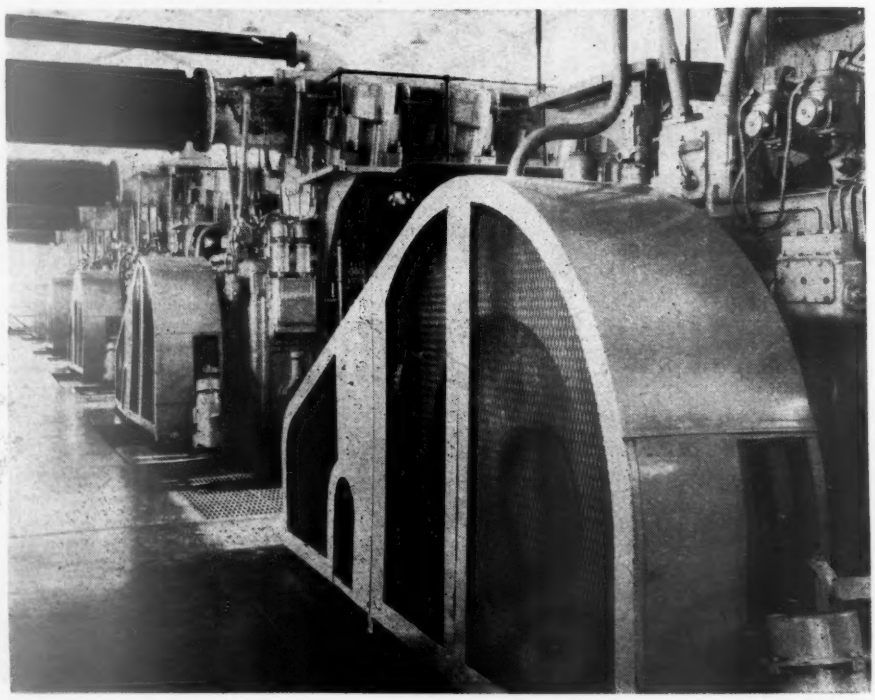
After the pipe was cleaned, a primer paint was applied, followed by a $\frac{3}{32}$-in. minimum coating of enamel and glass fiber wrapper. A second enamel coating was then applied with an asbestos pipe line felt wrapper. The whole was wrapped with asphalt board placed at 3-ft intervals for protection during installation. Sleeves were given an extra wrapping of felt and coated.

The pipe was made up in two sections. The first section was partially pulled, then the second section welded on and the whole pulled across the stream by means of draglines and tractors. The river bed was backfilled with broken rocks and the banks restored with dirt. To stabilize the banks, 5000 earth-filled bags were used, 2500 on each side. In addition, broken rock was placed on the banks to retard erosion.

Prior to installation the pipe was tested in two sections. The first section of 520 ft was given hydrostatic pressure of 850 psi, and the second section of 248 ft a pressure of 800 psi.

The crossing was "pigged" and blown during valve setting operations and simultaneously with the cleaning and purging of the main line. A preliminary test was made with gas pressure of 476 psi for a period of 12 hr using a dead weight gauge. A final test was made a few days later at gas pressure of 1025 psig for a period of 12 hr.

Five 2400-hp angle type 10-cylinder gas compressors have been installed at the field station, others are being installed.



Compressor Stations

Three compressor stations have been constructed and are in operation. These have a total horsepower of 21,600 and are pumping 155,000,000 cu ft of gas a day. The field station and dehydration plant are situated in Hansford County, Texas, about 12.5 miles south of Guymon, Oklahoma, and adjacent to Phillips Petroleum Company's gasoline stripping plant. The other two stations now in operation are at Onaga, Kansas, and Sandwich, Illinois.

Five 2400-hp angle type 10-cylinder gas compressors have been installed at the field station, and three 1600-hp 26-in. by 36-in. twin-tandem compressors at both the Onaga and Sandwich stations. Additional installations are now being made at all three stations.

For a proposed stage there will be a total of 15 compressor stations with an installed horsepower of 139,200 to deliver 303,000,000 cu ft of gas a day. Spacing of the stations will be approximately 75 miles. The approximate location, number of units, and proposed horsepower of all stations are tabulated in Table 1.

TABLE 1.

Station number	Location	Number of units	Horsepower
Field.....	Guymon, Oklahoma..	15	36,000
No. 1....	Meade, Kansas.....	6	7,920
No. 2....	Greensburg, Kansas...	6	7,920
No. 3....	Sterling, Kansas.....	6	7,920
No. 4....	Enterprise, Kansas...	6	7,920
No. 5....	Onaga, Kansas.....	5	8,000
No. 6....	Graham, Missouri....	6	8,400
No. 7....	Lineville, Iowa.....	6	7,920
No. 8....	Fairfield, Iowa.....	6	8,400
No. 9....	New Windsor, Illinois.	6	8,400
No. 10....	Sandwich, Illinois....	4	6,400
No. 11....	St. John, Indiana.....	5	6,000
Mich.-A..	Baroda, Michigan....	5	6,000
Mich.-B..	Hamilton, Michigan..	5	6,000
Wisc.-A..	Woodstock, Illinois	5	6,000

All stations will have angle-type compressor units except those at Onaga and Sandwich.

Under initial design the compressor units are operating at a compression ratio of 1.52 with an average intake pressure of 635 psig and an average discharge pressure of 975 psig. Under ultimate design conditions, the compression ratio will be approximately 1.38 with the average intake pressure 700 psig and average discharge pressure 975 psig.

Each station is designed as a complete self maintaining unit equipped with all necessary auxiliaries, a machine shop for maintenance, a warehouse for spare parts and equipment, and employee housing where neces-

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The No. 14P-HD (7¼"x1 ") Duplex Pump, (illustrated above), is one of four placed in service by a major pipe-line company about one year ago. This same pipe-line company has other "Oilwell"-Wilson-Snyder pumps which have been in continuous use for many years.

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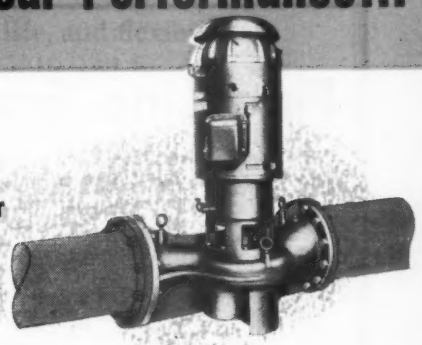

The "Oilwell"-Wilson-Snyder In Line Vertical Booster and Transfer Pump is designed to, (1) accelerate the flow of liquids in existing pipe lines, (2) circulate hot or cold liquids and (3) be used for general transfer service. It is also widely used to boost the pressure in the suction lines at pumping installations where adverse suction conditions exist. This type of pump is available for capacities ranging from 400 to 4000 gallons per minute and pressures up to 160 feet, with suction and discharge flange sizes from 6" to 16".

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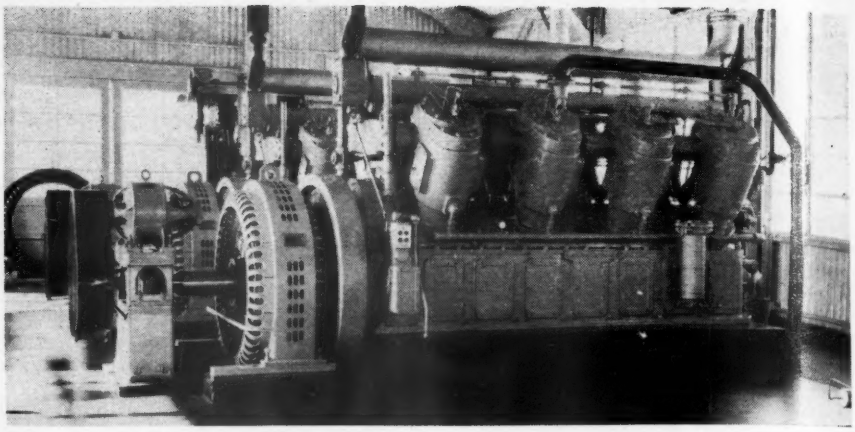

Gas engines of 347-bhp driving 300-kva generators at Hanford station.

sary because of remote location of some of the plants and in all cases for those employees subject to 24-hr call.

Inlet gas from the Phillips gasoline stripping plant is passed through the compressors at the field station for compression to 1000 psig. The gas then flows through the cooling tower and a battery of mist extractors to the dehydration plant before entering the 24-in. main line. Intermediate stations do not have liquid extractors, gas cooling, or dehydration.

Dehydration Plant

The dehydration plant is a solid adsorbent type using Florite activated bauxite and operates on a regenerative cycle. Five towers have been installed, designed to operate at a pressure of 1000 psig to dry 175,000,000 cu ft of gas a day to a dew point below 0 F. Provisions have been made in the design of the plant to permit increasing its capacity in increments of 87,500,000 cu ft a day by the addition of two towers and appurtenant equipment.

The design basis is for Hugoton natural gas having the following characteristics:

Specific gravity	0.69
Specific heat	0.60
Inlet temperature	90 F.
Water content	40 lb per MM cu ft (saturated at 90 F and 1000 psig)

Switching of towers from drying service to regenerating and back to drying is accomplished by electric motor actuated valves, which are controlled by an automatic control panel. With such valving and timing control the towers can be switched frequently for regeneration, thereby permitting the use of considerably smaller towers than is possible using conventional larger cycle lengths.

The compressor stations and dehydration plant were constructed by Ford, Bacon and Davis Construction Corporation of Monroe, Louisiana.

Gas Measuring Stations

Two types of measuring stations have been installed: City gate sales meter stations and check meter stations. For the initial stage of construction there are 20 sales meter stations. The sales meter stations are designed to deliver gas to the local distribution companies at a nominal pressure of 350 psig, but not to exceed 600 psig.

The one check meter on the system is placed upstream from the Austin field manifold. This meter is designed

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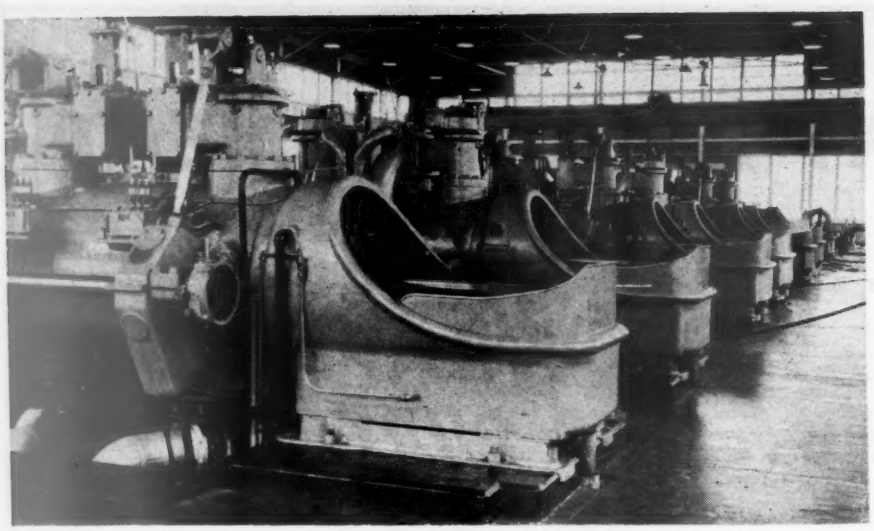

At the Onaga, Kansas, station three 1600-hp twin-tandem compressors are in operation. Here, also, other units are being added.

to operate at any pressure up to 1000 psig and at a capacity ranging from 25,000,000 to 300,000,000 cu ft a day at a pressure base of 14.735 psia.

Gas Storage

An unusual feature of the project is the use of existing underground gas storage fields in Michigan to store natural gas during summer periods for use during winter peaks. Such storage makes the peak delivery capacity of the system more than twice the capacity of the main line.

The annual in and out storage field capacity is approximately 28,000,000,000 (billion) cu ft, which will make it possible to operate the main line at practically 100 per cent capacity throughout the year. These storage fields are Austin field, Goodwell field, and Reed City field.

Management of Company

Michigan-Wisconsin Pipe Line Company, a Delaware corporation, has its principal place of business at 415 Clifford Street, Detroit, Michigan, and is a wholly-owned subsidiary of the American Natural Gas Company (formerly the American Light and Traction Company).

The principal officers are William G. Woolfolk, chairman of the board; Henry Fink, president; Charles T. Dickeman, executive vice president; and F. W. Sharp, vice president and treasurer.

Key men in the operating organization are Volney H. Kyle, Jr., operating manager; M. A. Hardie, chief engineer; Rex V. Campbell, compressor station superintendent; R. D. McClintock, pipe line superintendent; and C. R. Stephenson, measurement superintendent.

The operating personnel has been moved from Kansas City, Missouri, to Detroit in the Guardian Building on 500 Griswold Street.

The design and construction personnel of Ford, Bacon and Davis, Inc., under William B. Poor, project manager, also has been moved from Kansas City to Detroit. ***

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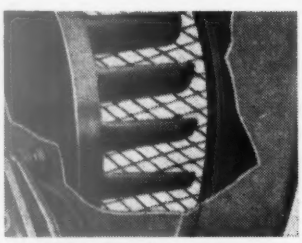

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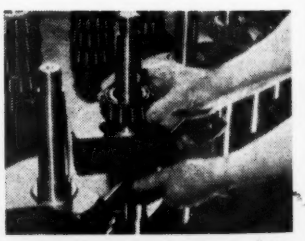

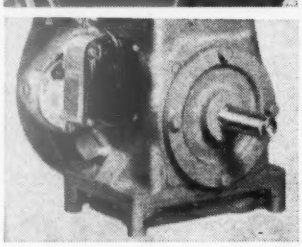

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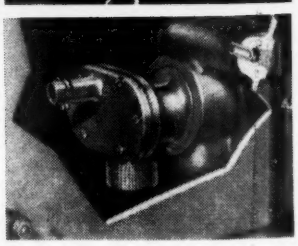

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View of the Portland Pipe Line Corporation tanker unloading pier at South Portland, Maine. It is a modern structure capable of docking two of the largest tankers afloat at one time. Built in 1946 following the destruction of original wood pile pier during a storm, it is 882 ft long and has 35 ft of water at mean low tide.

Plans for New Portland-Montreal Line

HARRY CHAPIN PLUMMER

THE Portland Pipe Line Corporation and the Montreal Pipe Line Company, Ltd., have had under study for some time projects for increasing the capacity of the system. The two companies have recently completed arrangements to construct a new main line 18-in. in diam, to be built over the same right-of-way between Portland and Montreal as the existing 12-in. line, with construction to begin in May and completion scheduled for November. When completed the new 18-in. line will be operated in conjunction with the 12-in. line, with three operating pump stations situated at South Portland and North Waterford in Maine, and at Lancaster, New Hampshire. The operation of five of the existing stations will be discontinued at that time. The new project also will include the construction of a new 30-in. discharge line from the unloading pier at South Portland to the tank farm, approximately 3 miles in length, four new 150,000-bbl floating roof tanks at the South Portland tank farm, together with additions and changes to manifolds at the three operating stations, and construction of delivery lines to the four refineries at Montreal East, Quebec.

After the new line is completed capacity for the system on average crudes will be approximately 127,000 bbl a day with three-station operation.

Existing System

The Portland-Montreal pipe line was constructed during 1941 as a defense measure to provide year-round deliveries of crude oil to the four refineries at Montreal East. Previously these refineries received delivery direct by tanker during seven months only due to the St. Lawrence River being ice-bound during the five winter months. The pipe line also eliminates approximately a 2000-mile round trip by tankers, which was particularly important during the war when there was a shortage of ships.

The system was constructed and financed in 1941 by the Standard Oil Company (New Jersey). During 1946 that company sold its entire interest in the system to four Canadian companies, The British American Oil Company, Ltd., Imperial Oil Limited, McColl-Frontenac Oil Company, Ltd., and the Shell Oil Company of Canada, Ltd. These companies are the present stockholders of the Portland Pipe Line Corporation, which owns and op-

EXCLUSIVE

Above: Crossing Rocky swampland in State of Maine.

Right: Looping "Big and Little Inch" pipe lines with 26" line in Ohio.

Associated's ability to construct pipe lines through most difficult terrain was selected to build a section of the 18" line to be laid through the States of New Hampshire and Vermont in 1950.

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(Formerly Associated Contractors & Engineers, Inc.)

A. L. Forbes, Jr., *President*
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Earl Allen, *Vice-President*
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HOUSTON, TEXAS

erates the section of the line from South Portland, Maine, to the International Border at North Troy, Vermont (160 miles), and also of the Montreal Pipe Line Company, Ltd., which owns and operates the pipe line system from the International Border to Montreal East (70 miles).

The main line is an all-steel welded line 12-in. in diam, built of seamless pipe having a wall thickness of 3/8-in. The total length of the main line is 236 miles, 70 miles of which runs through the Province of Quebec from the International Boundary at North Troy, Vermont, to Montreal East. In Canada there is a 1400-ft crossing of the Richelieu River and a 2½-mile crossing of the St. Lawrence River.

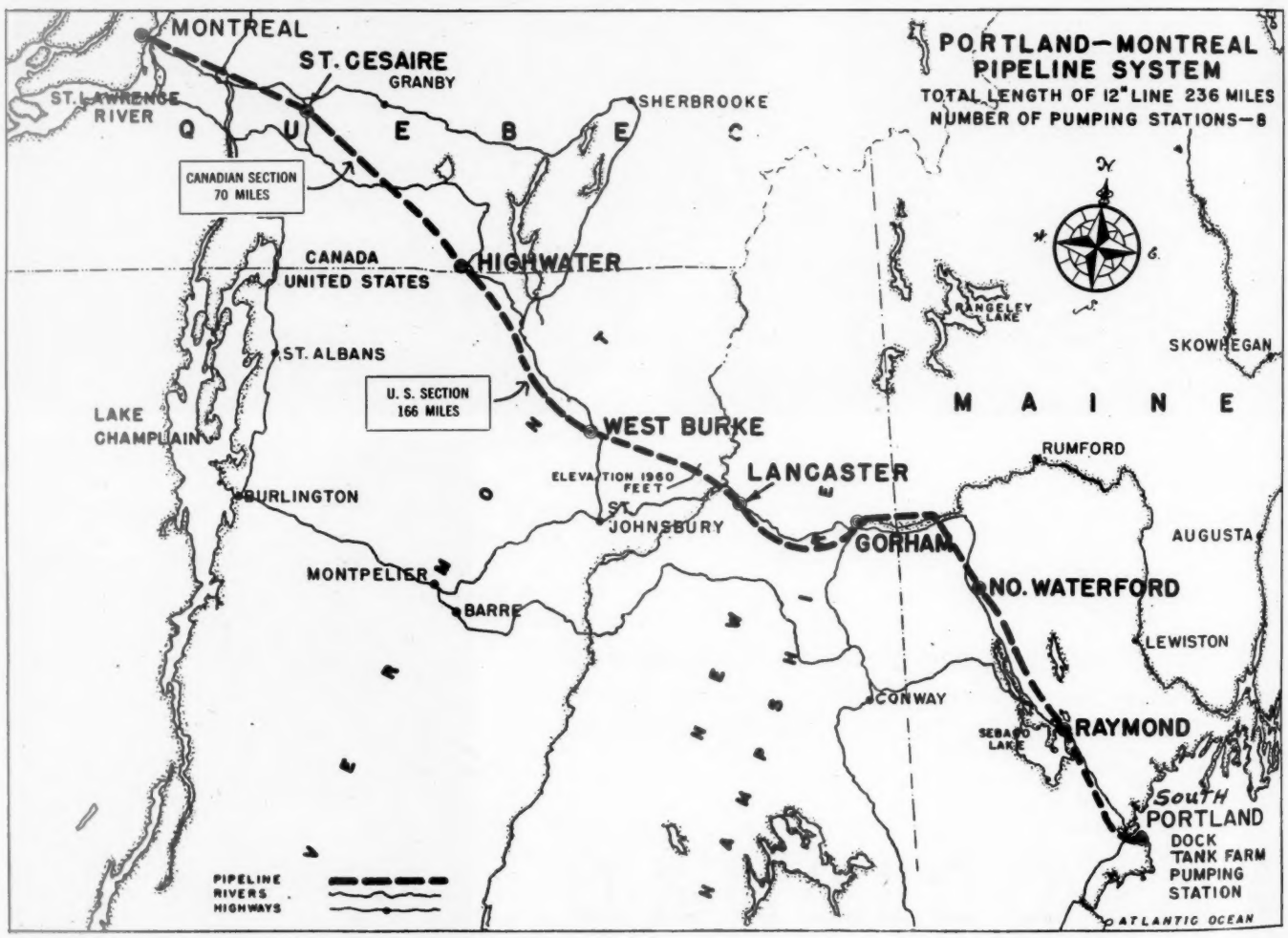
Eight main line pump stations are situated along the line, six in the United States and two in Canada, one at Highwater at the International Border and the other at St. Cesaire. Each station is equipped with two 30,000-bbl per-day triplex reciprocating pumps and one 20,000-bbl per-day duplex reciprocating pump, giving a total maximum pump capacity on light crude of 80,000 bbl per day. Six of the pump stations are electric-driven, with a 500-hp motor to operate each pump, and the other two stations are diesel-driven.

At the company's South Portland, Maine terminal the unloading pier is 882 ft in length with two berths dredged to 35 ft to take two tankers at one time. The pier construction is structural steel and concrete. Two unloading lines are provided on the pier. One 16-in. line handles discharge of vessels to two storage tanks situated on shore and the other, a 24-in. line approximately three miles in length, handles the discharge of vessels direct from the pier to the tank farm where the first main line pump station is situated. The present unloading lines are capable of handling discharge rates up to 15,000 bbl per hour on light crude.

Tankage at South Portland consists of six 140,000-bbl tanks and two 135,-000 -bbl tanks all equipped with floating roofs. Total capacity of 8 tanks is a little more than 1,100,000 bbl.

Most of the crude oil handled through the system is received by tanker from Venezuela, with occasional cargoes from Trinidad. During the past year some Arabian crude has been handled. The present system has a capacity of approximately 80,000 bbl per day on light crude, with some of the heavier crudes, depending on gravity and viscosity, moving at rates down to approximately 58,000 bbl per day in the winter time. Discharge pressures at the pump stations are held to a maximum of 850 psi. The quantity of crude handled through the system has increased each year since the beginning of operations as follows:

Year	Daily avg., bbl	Total bbl
1942	19,609	7,157,501
1943	31,657	11,554,830
1944	44,582	16,316,912
1945	43,543	15,893,077
1946	52,484	19,156,879
1947	59,275	21,635,384
1948	67,323	24,640,457
1949	68,563	25,025,668



Sketch map showing the route of the existing 12-in. system from South Portland, Maine, to Montreal East, Province of Quebec. Also shown are the locations of existing pump stations at South Portland, Raymond and North Waterford in Maine, Gorham and Lancaster in New Hampshire, West Burke in Vermont, and St. Cesaire and Highwater in the Province of Quebec. The new 18-in. line will parallel the 12-in.

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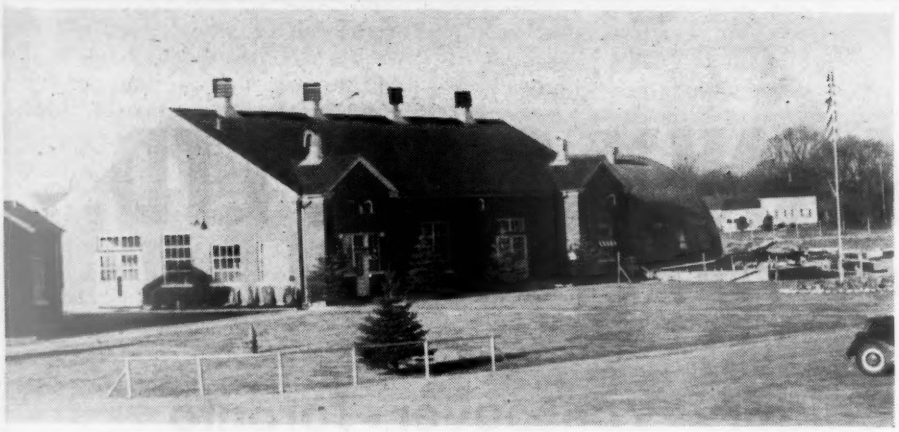
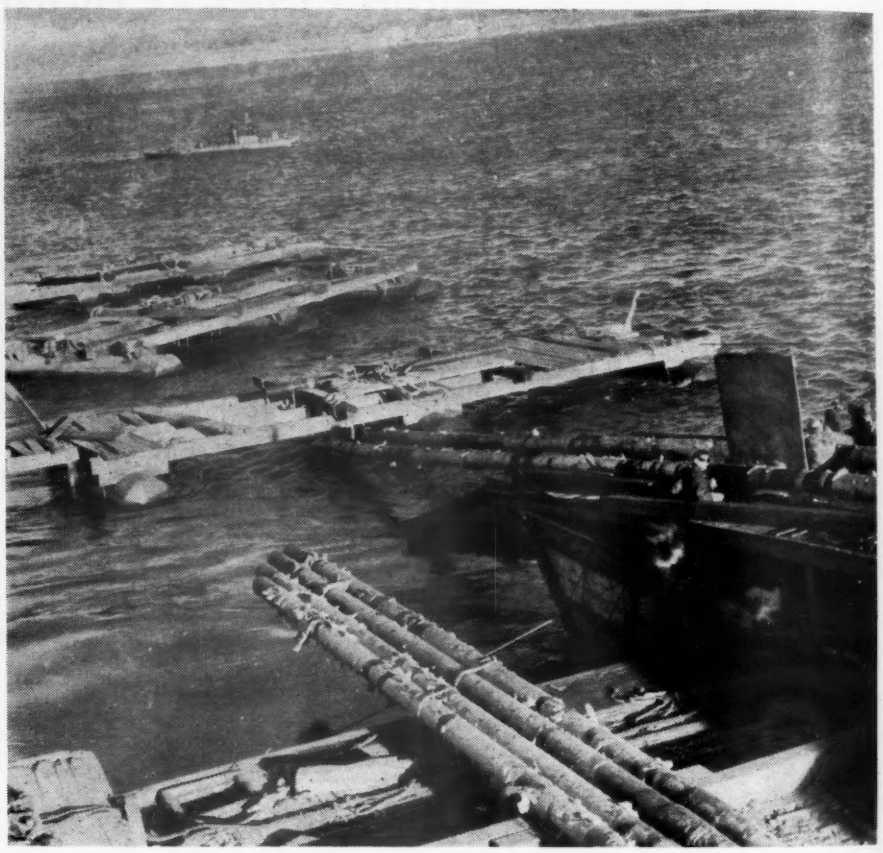


South Portland pump station showing foundation work, which is underway at present to extend building for housing additional pump units. Quonset hut shelter for the present third pumping unit will be replaced as part of this construction work. This is the first main line pumping station.

Below, two 10-in. lines that serve Montreal Pipe Line Company's present 12-in. system were being laid across the main channel of the St. Lawrence River. Crossing for new 18-in. line will be a single 18-in. seamless steel pipe with ½-in. wall thickness.



New Construction Plans

New construction plans contemplate following the right-of-way of the present 12-in. line, as stated, except at points of crossing the Richelieu and St. Lawrence Rivers, both in Quebec Province and virtually at the northern end of the system. In both instances the lines will be laid respectively 500 and 4000 ft west of the 12-in., chiefly to avoid damaging that line when blasting the rocky bottoms of the two streams. The same technique will be used in laying these crossings as was previously employed. The pipe will be laid from barges and cast-iron river clamps will be applied to add weight. The Richelieu and St. Lawrence are the two "toughest" streams to be crossed by reason of the swiftness of their currents, particularly the latter at and around Montreal. In fact, the pipe line crossing is at a point not far distant from the legendary "Pied du Courant" (Foot of the Current) of the Indians and the French "courriers."

The topography and soil characteristics of the country to be traversed by the new line includes the rough mountainous terrain of New Hampshire's White Mountains, Vermont's Green Mountains, and the foothills of the Laurentians in the Quebec area, gradually sloping to farm country in the Richelieu and St. Lawrence valleys. Rocky formations are encountered virtually from one to the other sea-level termini. Traversing such a right-of-way, it is obvious that considerable blasting will have to be done to make ditch. Through the better areas customary type ditching machines will be used.

As protection against corrosion the pipe will be cleaned externally and given a coat of coal-tar primer, followed by a coating of coal-tar enamel and a double wrap. To protect the coating and wrap from physical damage in the rocky areas, rock shields will be secured about the pipe before lowering it into the ditch. As a further protection against corrosion the installation of cathodic protection is being considered. At present the 12-in. line is given protection by magnesium anodes.

Wall thickness of the 18-in. pipe will vary, depending upon whether it is for use on the main line, at river crossings, etc. Pipe with 5/16-in. wall thickness will weigh 5903 lb per linear foot; 11/32-in. wall pipe, 6482 lb per ft, and ½-in. wall pipe, 6905 lb per ft. In welding, three beads will be run except in the case of river pipe, which will have four.

Inasmuch as the number of stations is being reduced from eight to three, it is not contemplated that additional pumps and prime movers will be required, even though, of course, two lines will be operated instead of one. Necessarily, there will be a relocation of equipment, however. The 12-in. line currently is being operated at a pressure of 750 to 850 psi, but the new system will be operated at 650 to 700 psi. Obviously, the 12-in. line is being operated at a forced pressure, but with increased capacity the pressure can be reduced.

Contractors who will lay the new line are: Associated Pipe Line Contractors, Inc., Houston, Texas; Oklahoma Contracting Corporation, Dallas, Texas; Fred Mannix Company, Ltd., Calgary, Alberta, Canada, and Latex Construction Company, Houston (river crossings). * * *

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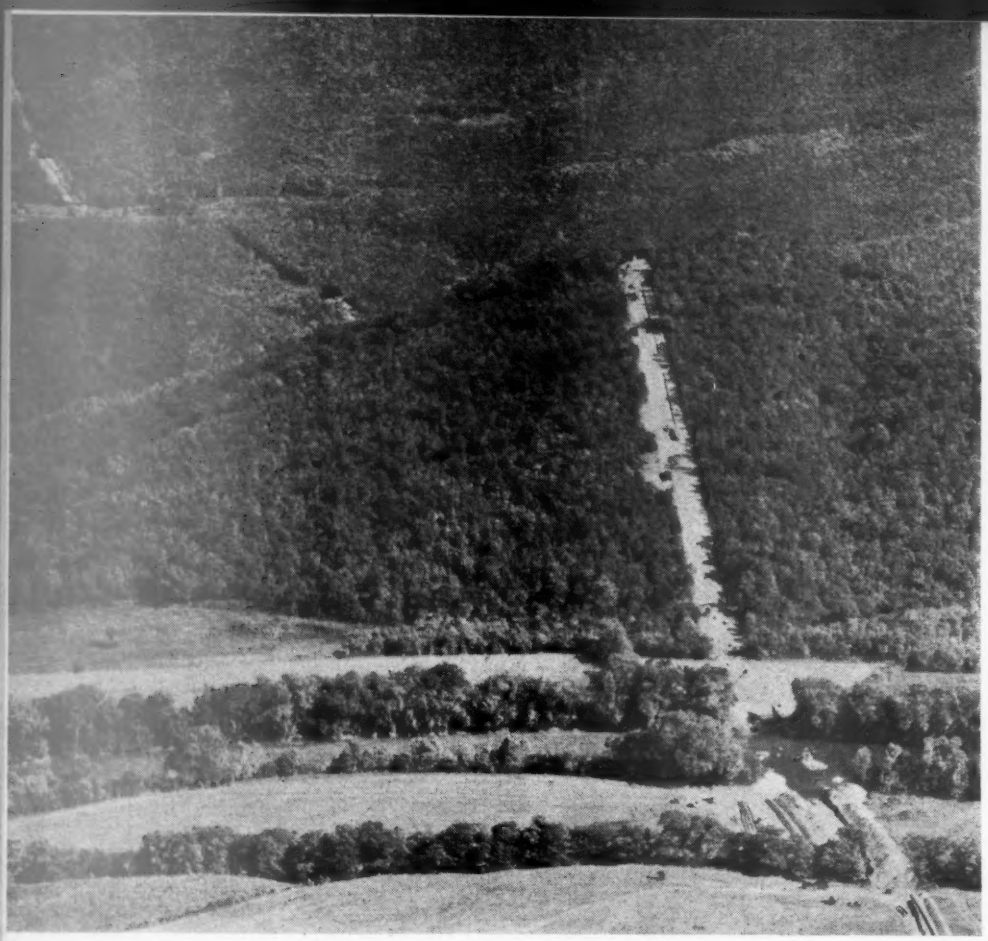


P 623.

An aerial view of the Shenandoah River Valley, showing preparations for the "Toughest Inch" crossing. The right-of-way and ditch can be seen extending into the background.

OPERATION WILDCAT

"Toughest Inch", transversing 268 miles over rugged Appalachian Mountains, beats deadline

DAVID J. KERR*

CONSTRUCTION of what has beome known as the "Toughest Inch" pipe line was completed recently in advance of the deadline set by the Columbia Gas System, Inc.

Labeled the "Toughest Inch" by veteran pipeliners soon after work began late last spring, this new pipe line stretches 268 miles from Cobb Station, near Charleston, West Virginia, to Rockville, Maryland, 203 miles of which was laid by the H. C. Price Company. Conquest of the rugged Appalachian Mountains ranks it with the foremost pipe line construction jobs of all times.

It is estimated that this was the highest priced natural gas line ever built. Total cost of constructing the "Toughest Inch" was approximately $15 per ft or almost $80,000 per mile. In the total operation more than 5,000,000 cu yd of rock and earth were moved and better than 1,500,000 lb of dynamite consumed.

As some indication of the problems that were surmounted in the "Toughest Inch", this article describes the final phase in building this all-important extension of Columbia Gas System's network to the Washington-Baltimore area. It is an intimate account of what was required to add the last link in this Herculean project.

EXCLUSIVE

*Public Relations Director, H. C. Price Company.

It was mid-November and buried deep within the Appalachian Mountains, 10 miles from the closest black top road and some 60 miles from the nearest town, the last gap of the "Toughest Inch" remained unfinished.

Bad weather had already arrived, bringing cold rains, chill winds, and snow—unmistakeable forebodings of a hard winter ahead. The good roads were icing over, and the bad roads had reached the impassable stage, muddy quagmires that had been chopped to bits by churning trucks and tractors.

With each passing day, the mountains seemed to grow higher, the inclines steeper, the rocks bigger, the mud deeper, and the rivers and streams wider. Nature appeared to have marshalled her strongest forces to withstand the efforts of the pipeliners.

And these pipe line men—the ones who carved out the ditch, handled the monstrous equipment, and welded the joints together—these men were tired, worn-out, and ready to head for home. Now, near the point of exhaustion, they had one more job to do—"Operation Wildcat".

Three spreads of the H. C. Price Company had started work on the "Toughest Inch" earlier in the year. One of these spreads was finishing the Potomac River crossing near Rockville, so the other two spreads—one out of Elkins and the other out of Weston, West Virginia—were sent in to fill the final gap. There weren't more than 15 miles of line to be completed, but it was unquestionably the toughest section of the "Toughest Inch", a pipe line construction job without equal in the United States.

An hour and a half of hard driving from Elkins would take you to the road's end so far as passenger cars were concerned. From here on in to where the pipe line was being laid you used a jeep, power wagon, or tractor equipment in order to traverse the narrow mountain trails where even the most powerful trucks bogged down in the deep mud or hung the rear axle over a steep cliff on some sharp curve.

"Wildcat"

Identifying this "transfer point" was an iron bridge over the Little Kanahwa River, a one-room white school house, and a couple of ramshackle miners' homes. The natives had quite

Stretching out like a giant Python a long section ready to be lowered-in atop one of the high Allegheny mountains.

appropriately named this place "Wildcat". And this appellation seemed altogether applicable to the rugged, end-of-the-line operation that the Price company had undertaken so that the "Toughest Inch" could be completed and essential gas could reach Baltimore and Washington by the first of the year.

Tired Men

Once underway the pipeliners spared no effort to get the job done. They had six months of back-breaking labor behind them, but they were not going to cry "uncle" now just because they were tired and ready for a visit back home. So, worn-out and exhausted, they kept going out on the line. No one paid any attention to what day of the week it was or whether it happened to be a holiday—everyone was out on the job seven days a week until it was completed. And it should be remembered that these were not "9 to 5:30 days". Rather the men headed for the line at 5:30 or six in the morning and returned at 7:30 or 8 at night. For these men and their patient families there was little time for sleep and none for recreation. This meant accumulated fatigue, worn nerves, slow reaction to danger, and short tempers.

Tired Machines

Moving in on "Operation Wildcat" with the tired men were the tired machines. The sidebooms, the backhoes, the ditchers, the tractors, and the trucks had all been run to the breaking point. All equipment needed overhaul and replacement at this stage, but now there were more treacherous

A sideboom holds a joint of pipe on a steep incline as welders hurry to add another link to the line. Note the cable stretching from the sideboom up the hill to a tractor that serves as an anchor.

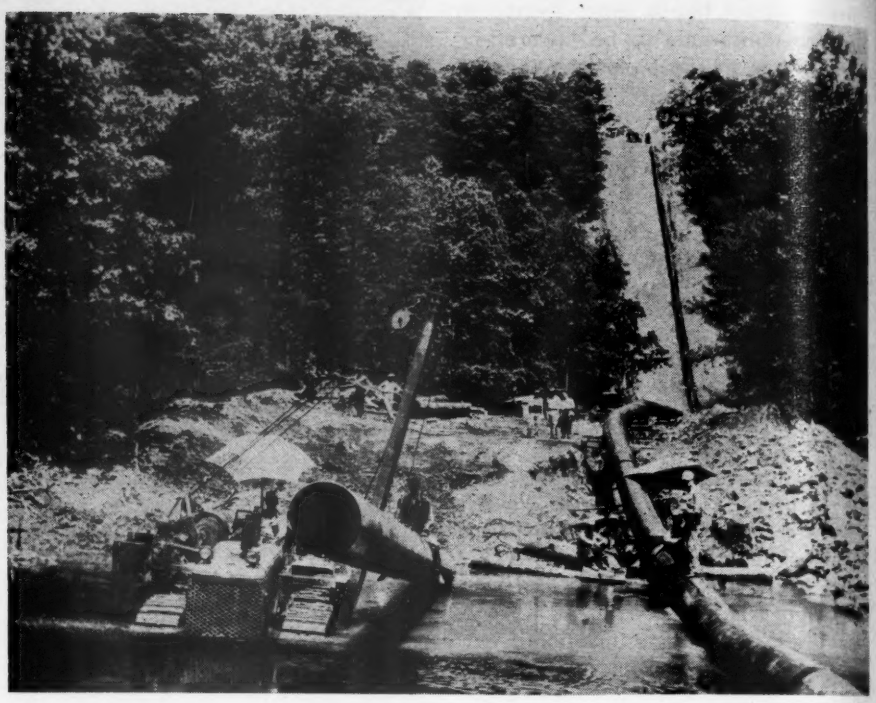
Rock, dirt, and water hurtle skyward as 6000 lb of dynamite blast out a ditch in the Potomac river bed. In the lower foreground can be seen a stockpile of pipe ready to be moved into the river crossing.

miles of pipe that had to be laid and no chance for a "time out" to repair or buy new machinery. Furthermore, most of the equipment was long miles from the scene of this final operation and it took many days to get it assembled at the "kick-off point". You can be sure that it is more than an overnight task to haul a ditcher 300 miles up and down those West Virginia mountains!

Wretched Weather

Good weather was a rarity. Most days brought bitter winds and freezing rain or snow. You can't work too long at a stretch under these conditions without moving to a campfire and thawing out a little. The sun had apparently taken a vacation, and the gray skies offered little encouragement even when they weren't pouring down torment on the men. And speaking of snow—there was plenty of that stuff. In one week more fell than the natives had seen during the entire winter last year.

Of course, after the weather got bad the roads grew worse—if that were possible—and it took longer and longer to get back and forth to the job. In fact, there were days when you started out from town on an icy highway and drove patiently for two or three hours at 15 miles an hour, only to have to turn back because it was too slick to make it over that last mountain. Or perhaps you had been "lucky" enough to get out to the line when one of those blinding blizzards struck. There was no choice but to quit, because you couldn't see a man a joint of pipe away and it was too dangerous to be wrestling equipment around those mountains under such conditions.



A sideboom manuevers a joint of 26-in. pipe across one of the many streams the "Toughest Inch" hurdled on its way across the Alleghenies.

Four 16-in. lines stretch towards the Potomac River crossing. Coated, wrapped, and with heavy concrete river clamp attached, these lines will withstand the punishment of spring floods and winter freezing conditions.

Hazardous Terrain

Tired men, tired machinery, wretched weather, and impassable roads. These would be a bad enough combination to cripple any pipe line construction job. But "Operation Wildcat" was not a run-of-the-mill project. It was the tail end and the toughest end of the "Toughest Inch". Here was terrain that defied man, mule, or machine. It seemed to either go straight up or straight down, and almost all the way there was oozing mud or impenetrable rock. This was countryside scarcely fit for the hardiest mountaineer, let alone for building a 26-in. pipe line!

Kicking Off

It seemed forever before equipment could be moved in and work started. Then came the difficult problem of two spreads kicking off from the same mountain top, one plunging immediately into a deep canyon on the east and the other falling into a sharp valley on the west. There was no room on this pinnacle for maneuvering. Equipment was often jammed so close together that you had to spend time-consuming minutes moving two or three pieces before you could get the one you needed.

Ditching Operations

Trying to claw a ditch out of those Appalachian mountains is one task that no one will ever ask for again! To save man-hours you attempted to use the gigantic ditching machines wherever there was enough dirt to make it worthwhile. But to put a ditcher on any 60-deg slope required four to six winch tractors to lower it down and then drag it up. It was a darn good day when you got 500 ft of ditch, either up or down.

Where you had expected to get good ditch with the machine, the buckets often could only scrape the surface dirt, exposing a lawer of solid granite below. This meant almost continuous blasting, the wagon drills being pumped up and down the mountains to make thousands of holes for untold tons of dynamite. And anytime you were ditching down hill it was necessary to wait until the entire slope was ready before blowing, as otherwise you could easily kill a man working at a lower level. Once the blasting was

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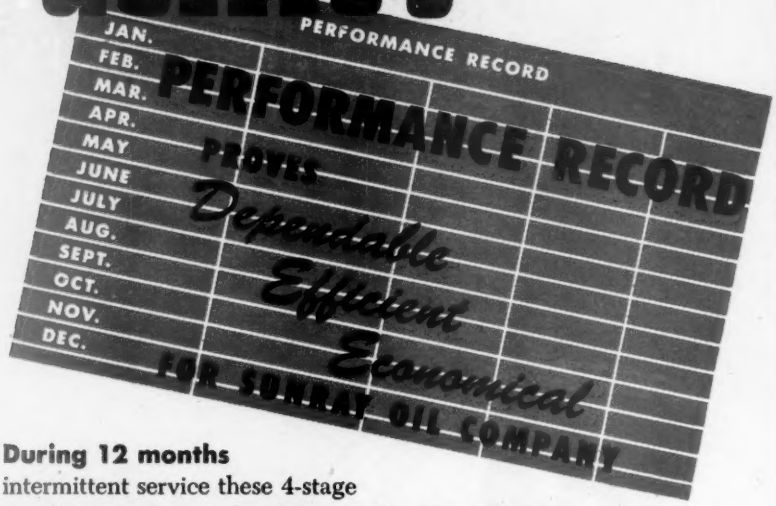

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done there remained the hazardous chore of cleaning out the ditch with backhoes, for these, too, had to be anchored securely before they could proceed to tackle one of the precipitous inclines.

Laying Pipe

Then finally there was enough ditch to start laying pipe! But on "Operation Wildcat" you could seldom find a joint of pipe strung near the ditch, as the big pipe trucks didn't even try to tackle this crazy right-of-way. This required tractor trips back and forth for every joint as the line started to snake out from the kick-off point. And you should have seen those pipe joints! By actual count, four out of five had to be bent before they would fit the line!

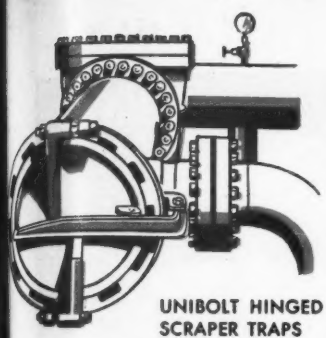
The days grew shorter, but still the pipe crept forward. One day the west spread would weld a dozen joints and be sick with discouragement, only to discover that the east spread had managed to get but six joints. So it went, miserable day upon miserable day, joint after joint, weld by weld.

Communications

Aside from all the imposing factors mentioned above, it is well to realize that there were many little problems that beset the pipeliners as they struggled with "Operation Wildcat". At least they were "little" in comparison with others, but they frequently presented major stumbling blocks. Communications is an example. Out there in the mountains even the best of radio equipment would often fail to respond. This made coordination almost impossible and caused exasperating delay in ordering out vital replacement parts for failing equipment from the nearest town. It made it extra difficult for the spread superintendents to keep adequate control over all their men. And it made the situation right rough when a man was injured and needed medical attention.

Despite all conceivable difficulties the new line was completed and in operation by the first of this year. And this was just in time, as the demand for nature's most precious fuel had reached the desperate stage in the city of Baltimore, while Washington was in urgent need of additional gas to augment its supply.

It cannot be forgotten that the entire job from Cobb station to Rockville was mighty tough. That's why the pipeliners spontaneously labeled it the "Toughest Inch" from the very start. But "Operation Wildcat" will be remembered by the men of H. C. Price Company as the toughest part of the "Toughest Inch"! ★ ★ ★



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Pipeliners

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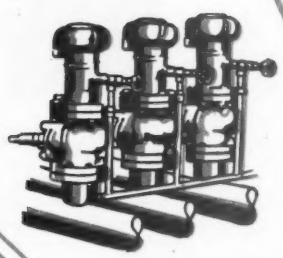
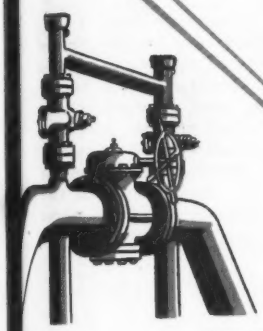
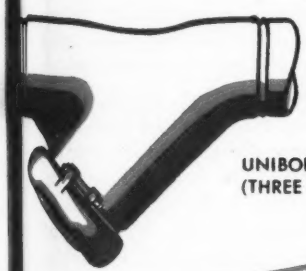


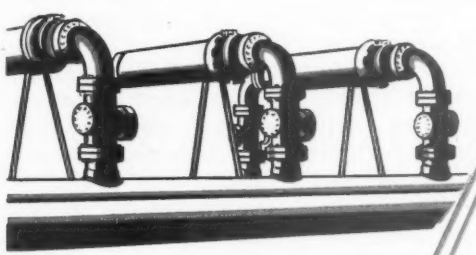
UNIBOLT COUPLINGS WITH BLANKING PLUGS ON TERMINAL MANIFOLDS



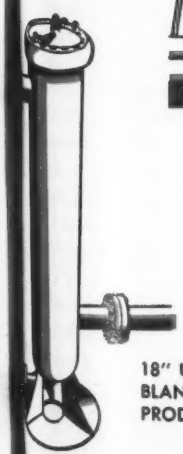
UNIBOLT COUPLINGS WITH BLANKING PLUGS ON GAS LINE BLOWDOWN



UNIBOLT STRAINERS— (THREE TYPES)



24" UNIBOLTS ON MAIN LINE GAS SCRUBBERS



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Presented here are the most common uses of UNIBOLT Couplings and blanking plugs in pipeline service. Complete details on each product will gladly be sent on request. Inquiries are invited on special pipeline manifold fabrication service.

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Pipe Line Communications

Carrier Telephone Systems

WARREN T. BULLA

The Author

Warren T. Bulla is superintendent of communications and dispatching for the Natural Gas Pipeline Company of America and makes his headquarters in Chicago, Illinois. For the last 25 years he has been engaged in communications work with oil and gas companies in the Midwest and Southwest. At present he is a member of the Mobile Radio Committee of the American Gas Association and vice chairman of the National Petroleum Radio Frequency Coordinating Association.

CARRIER telephone systems provide facilities for superimposing additional voice channels or telephone circuits upon existing voice frequency telephone circuits for the most part working over open-wire lines.

The two-wire telephone circuit has been used extensively by pipe line companies in their communication systems for years, but as the cost of erecting these facilities has increased, and as the "art" in carrier communication facilities has developed during the last 15 to 20 years, we have seen the general acceptance of carrier telephone systems until today they are used by most pipe line companies.

Carrier systems, generally, fall into two general headings: (1) Long haul systems and (2) short haul systems. Single and multi-channel equipment is obtainable for each of these headings.

The economical selection of a carrier telephone system depends upon such factors as number of circuits required initially, length of circuit, anticipated growth, size and physical condition of open wire circuit and pole line, length of entrance and intermediate cable, protection to service, crosstalk requirements, and cost of alternate methods of supplying facilities of equal transmission values. These factors will influence the installation of carrier systems and should be given careful consideration.

Carrier systems will, in general, provide voice transmissions with much better quality than that obtained from open-wire circuits.

Carrier current systems are devices for translating the basic voice frequency bands to higher bands of frequencies of equal width for transmission over a communication line, and, after transmission, retranslating these bands back to their basic frequencies. In "land line" communication the frequencies below 3000 cycles per second are usually referred to as "voice frequencies", whereas those above 3000 cycles per second are usually referred to as "carrier frequencies".

The translation of lower frequencies to the desired carrier frequency range is referred to as "modulation". The modulation process is accomplished by a "modulator", which may be any one of several devices, known as "non-linear" impedances. Fundamentally, modulation consists of mixing the voice frequencies with a carrier frequency created by a suitable oscillator or generator. The most important products resulting from modulation are two new bands of frequencies, each having the same width as the original voice band. One of these bands is referred to as the "lower sideband" and covers the range of frequencies that constitute the *difference* between the carrier frequency and each of the voice frequencies present. The other of these bands is referred to as the "upper sideband" and covers the range of frequencies that constitute the *sum* of the carrier frequency and each of the voice frequencies present. For example, if we assume a voice band of from 200 to 2800 cycles, which is approximately the range of frequencies required for intelligible transmission of speech, and assume a carrier frequency of 7150 cycles, then the lower sideband will extend from 6950 cycles (7150-200) down to 4350 cycles (7150-2800); similarly, the upper sideband will extend from 7350 cycles (7150 + 200) up to 9950 cycles (7150 + 2800). In telephone carrier systems usually only one of the sidebands is transmitted, the unwanted sideband being suppressed in the carrier apparatus.

Pipe line companies, in considering carrier installations, must consider the physical circuit, or circuits, they plan to use to be sure they are properly balanced to eliminate inductive interference and to minimize capacity unbalance. The transposition of wires to accomplish this purpose on open-wire facilities can be handled by using brackets, of which there are several on the market.

The best engineering practice is to cause the transpositions to occur at specific locations, measured to an exact point, therefore the brackets used are known as "Point brackets", which effect the transposition of a pair of wires on a single bracket by providing diagonally opposite pins at the correct elevation. (See Figs. 1 and 2 showing two manufacturers' Point brackets.)

Fig. 1. Illustrates the Point type transposition bracket fabricated of galvanized steel.

Fig. 2. Illustrates the Span transposition bracket fabricated of magnesium.

These two brackets indicate the sturdiness of the product and the exactness at which the transposition can be effected, both very desirable features.

A wide choice of carrier telephone apparatus is available from various manufacturers. In general the frequency assignments on which these operate have been selected to permit coordination between the various types. The recognized frequency assignment involves the space from approximately 6 kc to 15 kc from east to west or north to south transmission, and from approximately 17 kc to 32 kc from west to east transmission. In addition, there are lower frequency systems with assignment of from about 3.5 kc to about 6 kc from west to east or south to north transmission; with

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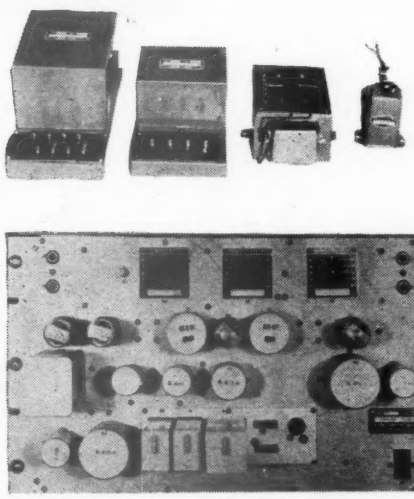

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FIG. 1. Point bracket fabricated of galvanized steel.

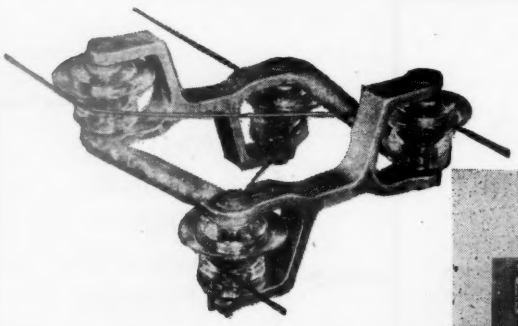


FIG. 2. Point bracket of magnesium.

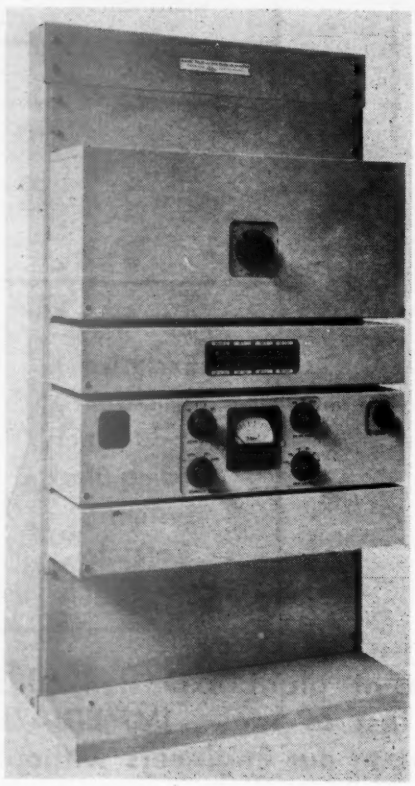


FIG. 4. Single-channel carrier telephone terminal with transmission measuring set.

FIG. 3. Carrier telephone repeater station on Keystone Pipe Line Company system.

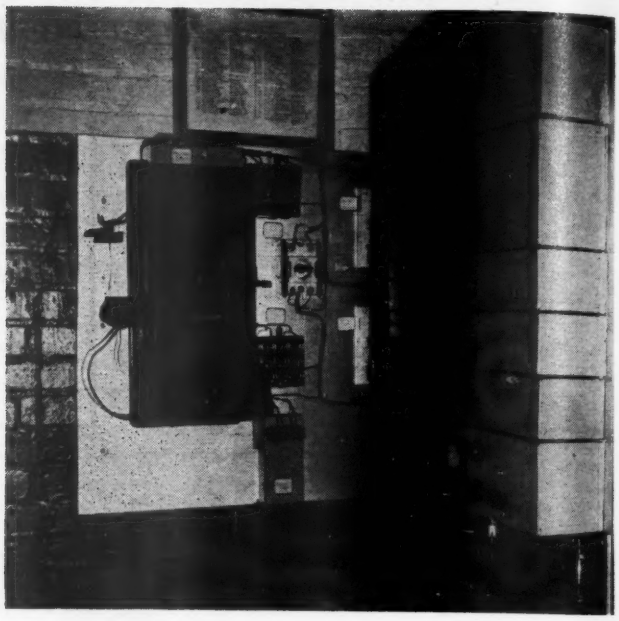
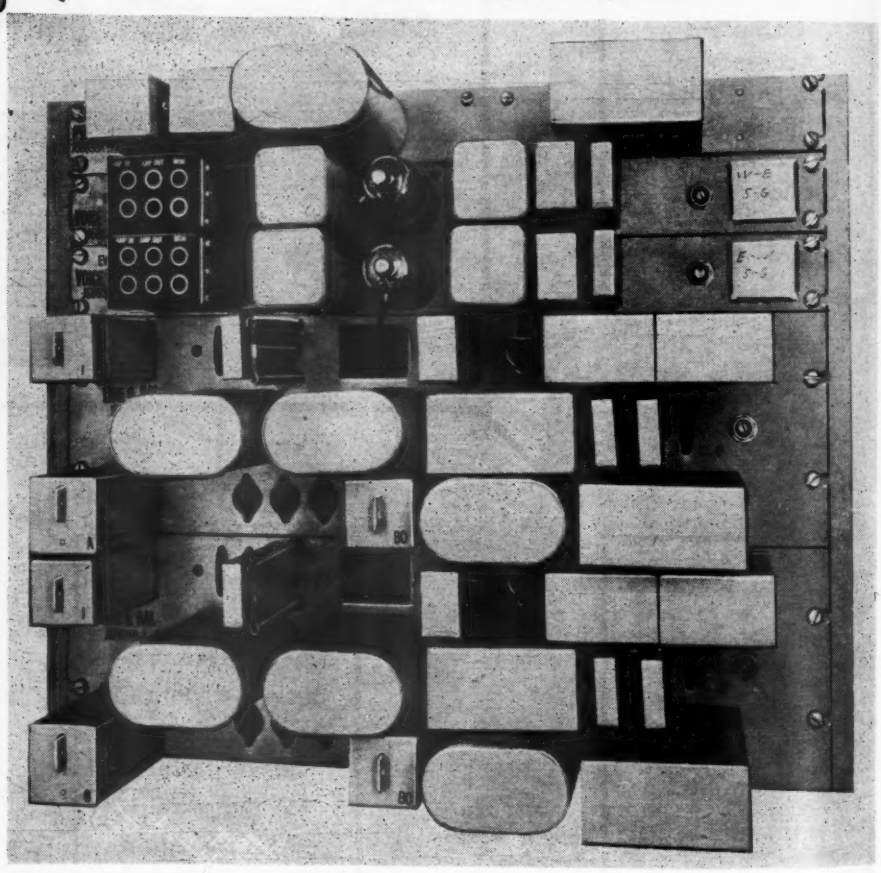


FIG. 5. Telephone repeater.



the higher frequency being arranged to coordinate with the 6 kc to 15 kc direction as above. Some special systems of low initial cost, which do not coordinate, have from time to time been made available, but are usually not economical, except where it is definitely established that not more than one carrier system is planned for that section, for the difficulties of coordination introduce a lack of flexibility that may offset the initial saving made.

Carrier systems may be obtained as single or multiple channel systems. Certain single channel systems are so arranged that additional channels can

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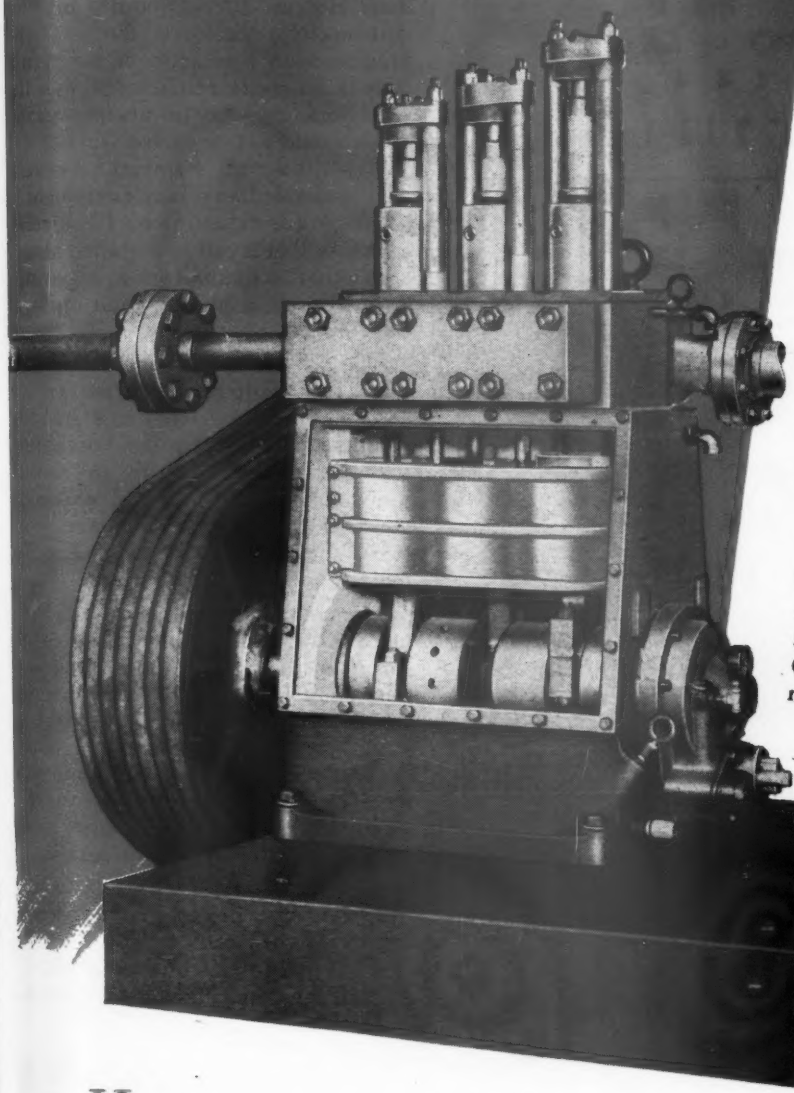

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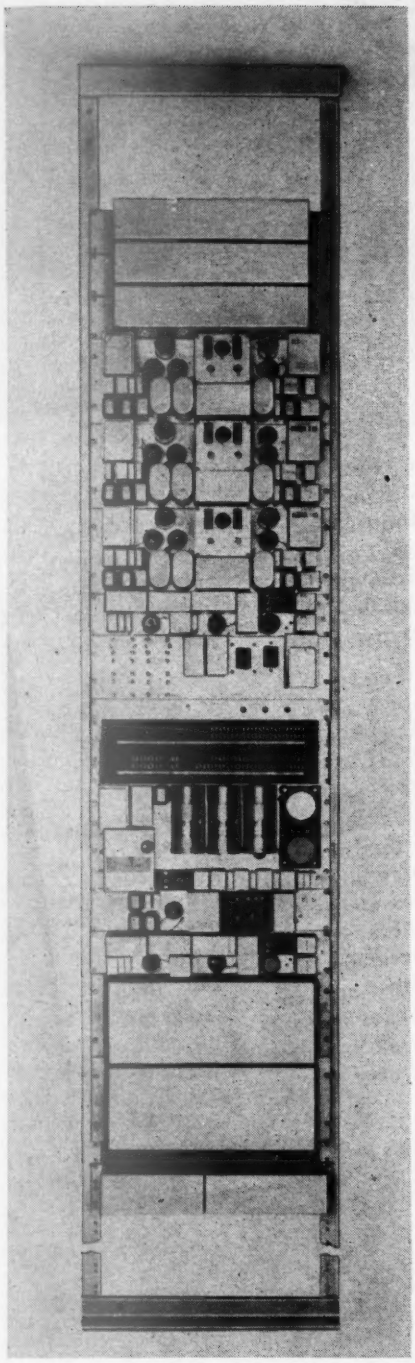


FIG. 6. Carrier terminal, used at each end of telephone system for termination of three-carrier channels.

be added on a unit basis, ultimately providing three-channel operation on the same frequency allocation as the three-channel equipment. Rather wide variations in transmission performances are obtained over the various systems and special limitations as to the length of circuit will apply to a number of systems. Manufacturers' data should be carefully examined when such systems are selected to determine whether or not transmission requirements are met.

The location of terminals or repeaters will probably be governed largely by the availability of established pump stations or other suitable locations. In addition, the cost of improving line facilities to obtain longer repeater spacing should be weighed against the cost of providing additional repeater or repeaters in order to obtain satisfactory operation.

All long haul carrier systems should be equipped with pilot, and preferably with automatic, regulation. Short haul systems do not require pilot or automatic regulation, because the transmission loss between the terminals is generally restricted so that the level changes due to weather variations would not be excessive.

Practically all terminal, repeater, and associated auxiliary equipment is available for mounting on 19-in. relay racks, so that it can be installed alongside other communication apparatus and maintain a pleasing and uniform appearance.

The power supply can be provided from local batteries or from an a-c source. The provision for a standby source of power may be considered necessary with the choice depending upon, among other things, economic considerations, standard power practices, space requirements, and maintenance problems.

The characteristics of the telephone circuits over which carrier systems are to be operated are of utmost importance and in order to plan a carrier system successfully, it is necessary to work up complete information, as per the following, in order that your own communication engineers or manufacturers representatives may offer their recommendations for consideration:

1. Diagrammatic sketch showing telephone line being considered.
2. Type of circuit.
3. Length of open-wire circuit.
4. Gauge, spacing, and type of conductors.

FIG. 7. Three-channel carrier telephone system, including power supply and filters.

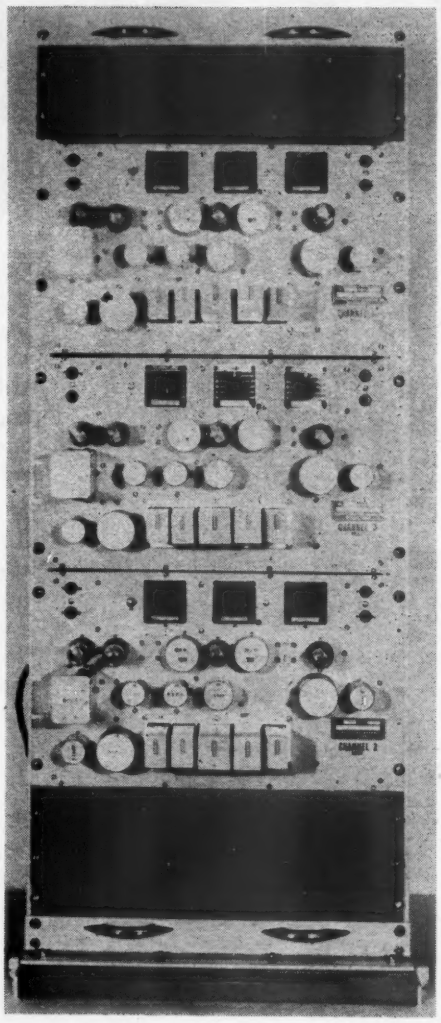
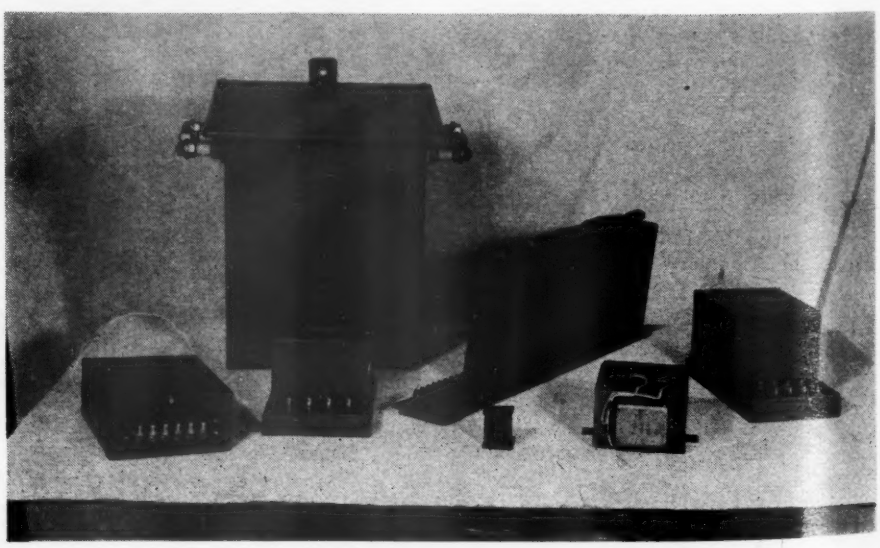


FIG. 8. Auxiliary line equipment, line and station filters, insulating transformers, etc.



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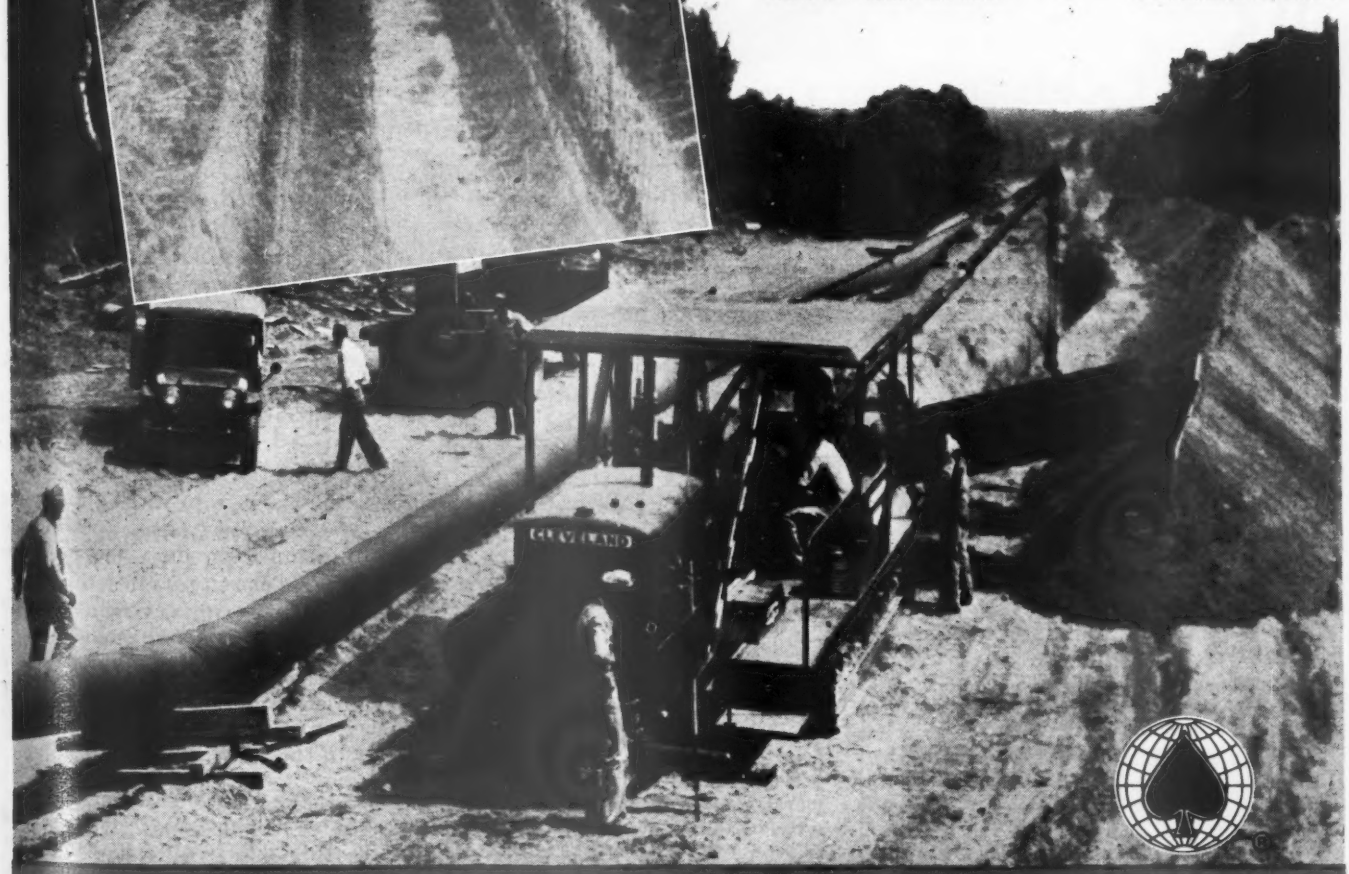

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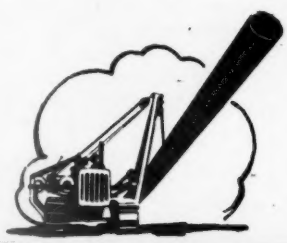

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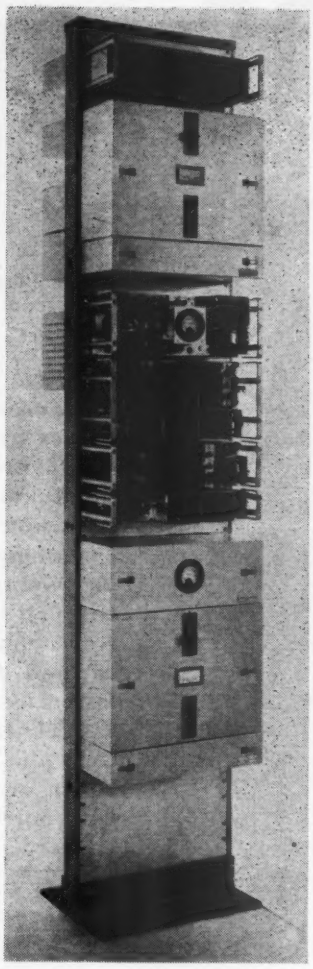


FIG. 9. Three-channel carrier terminal with P. C. regulators and high level channel amplifier.

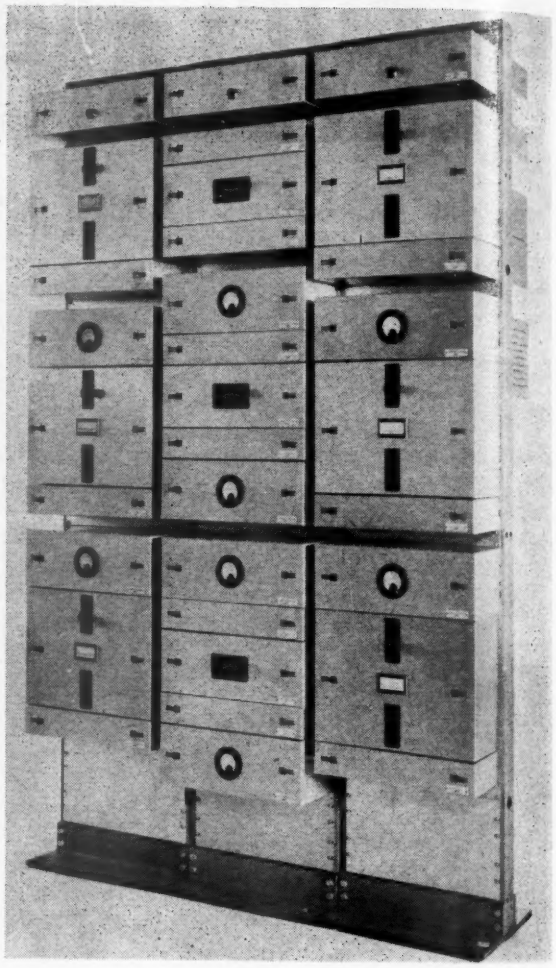


FIG. 10. Three-channel carrier system. (West terminal—repeater—east terminal.)

5. Location, length, and gauge of cable sections.
6. Loading details of cable sections.
7. Transposition layout.
8. Information as to all voice-frequency facilities operated on the circuit to be used. This should include:
   a. Location of all bridged telephone instruments.
   b. Length, gauge, type.
   c. Location of existing voice repeaters.
   d. Type and location of all Simplex repeating and drainage coils.
   e. Location and description of composite sets and other special equipment.
9. Information on power lines to which the facilities will be exposed.
10. Complete information regarding all carrier systems operating or planned on the same pole line or in close proximity.

Oil and gas pipe line companies have many carrier installations in service that have provided a rapid means of adding additional talking circuits as their requirements demanded.

To Spend $3½ Billion

Gas utility companies have mapped out a 3.5-billion-dollar expansion program for the 5-year period 1948 through 1952. Expenditures for natural gas projects constitute more than 80 per cent of the total, and pipe lines to serve the American public are by far the largest single item. Construction totals for the 5-year period are: Natural gas, 2.9 billion; manufactured gas, 478 million; mixed gas, 90 million; liquefied petroleum gas, 8 million.

Acknowledgements

Acknowledgments for pictures and data are made to the Federal Telephone and Radio Corporation, Western Electric Company, Automatic Electric Company, Hubbard and Company, Transandean Associates, Inc., and Southern Electric and Transmission Company. * * *

New Displacement Method for Measuring Gas Flow

J. C. WRIGHT

The Author

J. C. Wright, assistant superintendent of pipe lines, Panhandle Eastern Pipe Line Company, served with Panhandle as welder, district foreman, division superintendent, and superintendent of gas control before assuming his present duties in 1947. He has worked with Panhandle and predecessor companies since 1927.

THE important thing in determining flow efficiency of pipe lines is to know the Q, or quantity, of gas flowing through the pipe line under prevailing conditions. A new method, described in this article, has been developed whereby this flow can be determined economically, accurately, and quickly by displacement calculations.

In the past many natural gas pipe lines were constructed and put into operation without any cleaning except the conventional blowing, which at that time seemed ample for removing skids, rabbits, shovels, and other foreign objects. During this blow a considerable amount of loose dirt, rust, and mill scale would be removed from the pipe line, but seldom was gas velocity sufficient to remove all the loose substance, and certainly not the large amount stuck to the interior wall of the pipe.

Solid welded construction using internal line-up apparatus has greatly lessened the possibility of leaving large obstacles in the lines. Also, it is the general practice now to use internal cleaners on gas transmission lines following completion of construction and previous to placing the lines in operation. By doing this the problem of maintaining high flow efficiency is relatively easy.

The condition of the interior walls of pipe will vary even though the line was constructed of the same type and make of material throughout and constructed by the same contractor in a continuous operation. Some of the things affecting the condition of the interior walls are topography and type of soil in the area (these influence the amount of dirt, dust, and water that will get into the pipe line during construction, whether the pipe was stored a considerable time or put into the line immediately upon receipt of shipment), weather conditions existing during the construction period, and quality of construction.

On lines that were not cleaned properly previous to placing them in operation, the flow efficiency may vary greatly; therefore, before a cleaning program can be initiated intelligently, it is important to determine the flow efficiency of the pipe line in question.

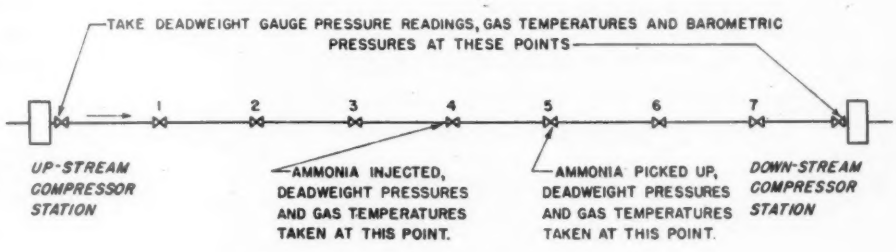
In the past the Q has been determined with fixed measuring stations when available and with portable pitot tube installations when fixed facilities were not available. Check measuring stations on long gas transmission lines are normally spaced at long intervals and, therefore, are usually of small benefit in conducting flow tests. Portable pitot tube installations are expensive in that special taps must be installed at a location where the line has a straight run of pipe for a considerable distance.

A pitot tube previously calibrated by a fixed orifice measuring station has been found to be usually constant for the particular location where calibrated, but it can only be assumed that the same calibration factor is correct at any other location. Also, any change in the interior walls of the pipe at the pitot tube location will materially change the results of the gas measurement. This condition may come about due to cleaning the section of line or by a deposit of foreign matter on the pipe walls.

On long natural gas transmission lines compressor stations are normally from 75 to 100 miles apart. For convenience and economy it is a good practice to conduct a flow efficiency test from the discharge side of the upstream compressor station to the intake side of the downstream compressor station. (Fig. 1 shows a typical set-up for this test.) These two compressor stations should operate at constant pressures on the section of line being tested for a period sufficient to stabilize the flow and pressures previous to the time of testing, and continue to operate with constant pressures during the test. Should this test indicate a low overall flow efficiency, a test can then be made between each main line gate valve to determine whether the entire line is low in efficiency or whether the condition is confined to areas between certain valves. The set-up for this test is the same as shown in Fig. 1 except that deadweight gauges and thermometers are set up at each main line gate valve.

Tests conducted during the past year have fairly well proved that measurement of gas flow through pipe lines can be calculated more accurately and economically by displacement than by portable pitot tube settings. The displacement method is conducted by calculating the volume in a known length of pipe line; upstream and downstream pressures, gas temperatures, and barometric pressures are then taken. With these known quantities,

FIG. 1


TAKE DEADWEIGHT GAUGE PRESSURE READINGS, GAS TEMPERATURES AND BAROMETRIC PRESSURES AT THESE POINTS
1
2
3
4
5
6
7
UP-STREAM COMPRESSOR STATION
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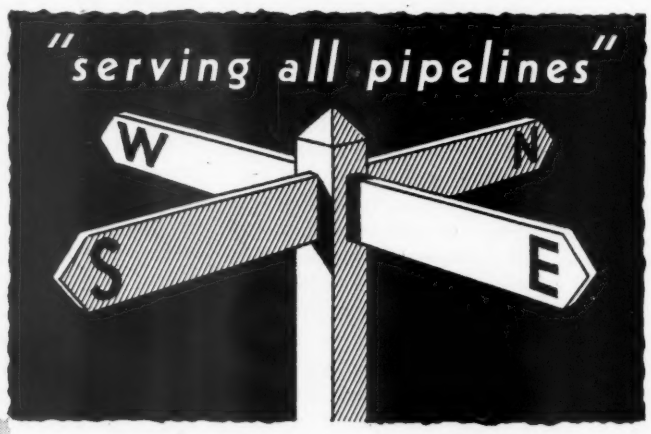

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the amount of gas in the section of pipe line can be calculated accurately.

Formula

$$Q = V \times \frac{Pm}{Pa} \times Tf \times Fpv$$

Where:

Q = quantity of gas in test section,
V = volume of test section,
Pm = absolute mean pressure,
Pa = barometric pressure,
Tf = mean gas temperature factor,
Fpv = supercompressibility factor.

Note: The supercompressibility factor was used in the test referred to in this article. The use of this factor is optional.

The next step is to arrive at the time it takes the test section of pipe line to empty and refill itself with a like quantity of gas. To do this, the following method is used:

A quantity of ammonia is injected into the gas stream through the blow-off at the upstream end of the section of line. This is done by use of a lubricator. (See Fig. 2). By use of a sampling tube (See Fig. 3) placed at the downstream end of the section of line, gas is taken from the center of the pipe line and conducted to a piece of filter paper, which is kept saturated with methyl red solution. The moment ammonia is present, a discoloration of the filter paper occurs. At that instant the original quantity of gas in the line has been emptied and if no changes in pressures have been made the section has been refilled with a like quantity of gas.

A stop watch is started the moment the ammonia is injected and stopped at the first notice of discoloration of the filter paper. Deadweight pressures, gas temperatures, and barometric pressures, which are the relative values needed, are taken at the time the ammonia is injected and again at the time the ammonia arrives at the downstream end of the section of line. With the known volume of the section of line and the known time it takes to empty and refill the section, the quantity of gas flowing can be calculated readily. The 24-hr flow rate would be:

$$Q = \frac{24}{T} \times V$$

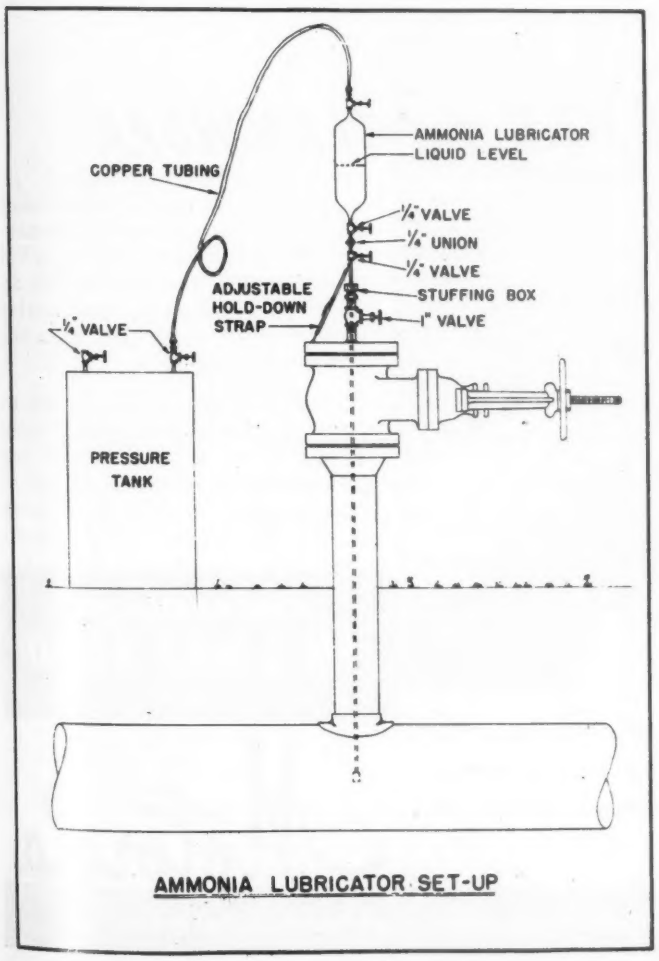
Where:

T = time between injection and detection points,
V = volume of gas between injection and detection points,
Q = actual volume passing in 24 hr.

The first tests conducted by this method were made on sections of lines where check meters were placed at the point samples were taken, and results on three different lines checked within 1 per cent of the permanent measuring stations. The sections of line in each case were approximately 18 miles. During the first test, the elapsed time from the first discoloration of the filter paper until the last trace of ammonia-laden gas passed the sample tube was approximately 5 min. In making later tests, the amount of ammonia was reduced and the elapsed time required for the slug of ammonia-laden gas to pass the sample tube was from 30 seconds to 3 minutes, depending on the velocity of the flowing gas.

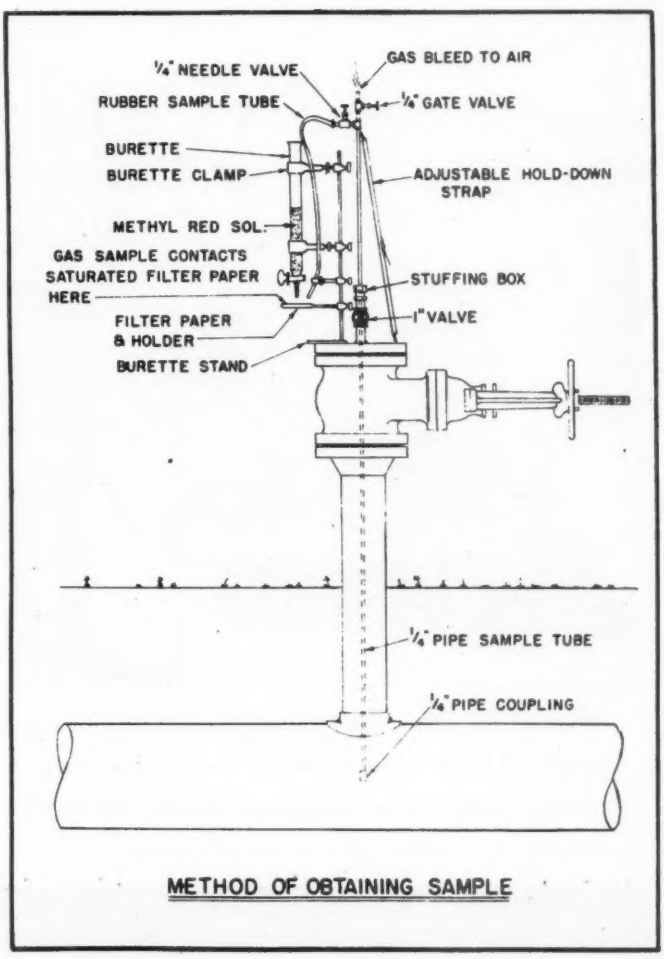
The length of the slug is determined by the amount of time it takes the ammonia to vaporize and be absorbed into the gas stream. Actually, the length of the slug is of little importance as the time used in calculating the Q is from the time the ammonia is injected to the time the very first trace discolors the saturated filter paper. The following is a typical report of samples taken:

FIG. 2



AMMONIA LUBRICATOR SET-UP

FIG. 3



METHOD OF OBTAINING SAMPLE

Location	*Time*	*Ammonia present*
Gate 205	11:15 A.M.	None
Gate 205	11:16 A.M.	None
Gate 205	11:17 A.M.	None
Gate 205	11:17½ A.M.	Trace (stopped watch)
Gate 205	11:18 A.M.	Strong
Gate 205	11:18½ A.M.	Strong
Gate 205	11:19 A.M.	Weak
Gate 205	11:19½ A.M.	None
Gate 205	11:20 A.M.	None

Note: A second watch was used for time after first watch was stopped.

When the ammonia is injected, the pressure on the lubricator must be considerably greater than on the pipe line. This assures quick and complete injection of the ammonia. A quick opening valve is used to release the charge and a stop watch is started simultaneously with the opening of the valve. This watch can be moved ahead to the location of sampling tube or the exact time transferred ahead if adequate communications are available. In the tests referred to here radio communication was used.

From actual flow tests conducted by this method on more than 1200 miles of line the past year, it has been determined that best results are obtained when the ammonia is injected into the line at a location where gas temperatures are nearly stable. This is normally from 25 to 35 miles downstream from a compressor station. This distance varies a great deal, however, according to ground temperatures and original temperature of the gas when it is discharged into the line at the upstream compressor station. The distance from the point the ammonia is injected to the location of the sample tube can vary, but 8 to 12 miles between these points seems best for normal operating and economical reasons. Multiple line river crossings, when in the section carrying the ammonia, will normally cause an error in velocity calculations and a corresponding error in flow measurement.

The ammonia is present in the gas stream near the outside walls of the pipe within a few seconds after it is detected in the center of the gas stream. There appears to be no noticeable molecular action due to the difference in weight of the molecules in the ammonia from those in the natural gas. The ¼-in. pipe injection and sampling tubes can be easily inserted into the line by hand. This was done on lines operating with pressures in excess of 800 psi.

These ¼-in. pipe tubes for injecting the ammonia should be of sufficient length that ammonia will be released directly into the gas stream and the sample tube should be set in such a position that samples are being taken at or near the center of the gas stream.

Velocity calculations made from an estimate of the flow rate will give the approximate time the ammonia will arrive at the sampling tube, therefore it is not necessary to start sampling until just a few minutes before the ammonia is expected to arrive. When sampling starts, sufficient gas should be bled to the air so there will be no appreciable time lag from the time ammonia enters the sampling tube until it reaches the filter paper. The gas bled is controlled by a ¼-in. valve on top of the tube and a small flow is maintained through the rubber tube to the saturated filter paper regardless of the amount of gas bled to the air.

This method of measuring the quantity of gas flowing through a pipe line requires a small investment in equipment. There is no expense for putting taps on the line, provided the line is equipped with blow-offs. If blow-offs are not available, then tests can be made by simply installing 1-in. taps at the points where ammonia is to be injected and detected. Actual cost of material used in conducting a test is negligible and a minimum number of employees required. * * *

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1924—The rotary movement is announced by Ashcroft.

1929—The phenol condensate plastic case is an Ashcroft "first" this year.

1932—Bourdon Tubes of stainless steels are announced by Ashcroft research engineers.

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1939—"K" Monel Bourdon Tubes, for services that would corrode stainless steel, introduced by Ashcroft.

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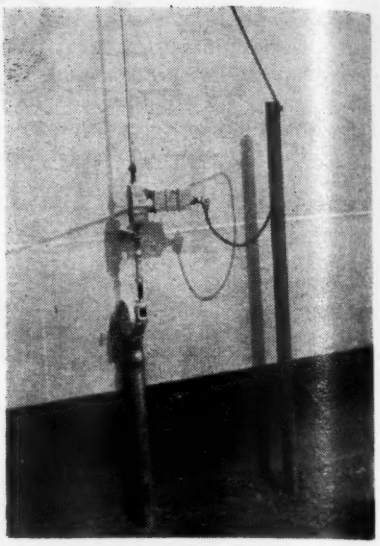
EXCLUSIVE

Remote Control Gauging

JOHN A. SLEETH*



Typical installation of selsyn motor transmitter for remote reading tank gauge. These installations incorporate ground level reading gauges to facilitate adjusting the reading to correspond to the gravity of the oil being measured.

EVER since the beginning of the oil industry, one of its major problems has been the accurate measurement of oil and its liquid products in tankage, and it might seem somewhat strange to the scientific mind that in such a progressive institution, the tape and bob method should still be most universally applied. Nevertheless, this is easy to understand. Largely it is due to the desire of the operators to avoid controversy with lessors, vendors, and purchasers of petroleum and its products.

The tape and bob method has been so long standard and accepted procedure that in transactions involving royalty, or the purchase or sale of oil products, the parties to such transactions are loath to veer away from well proved practice. Indeed, any departure from presently stipulated methods in such instances must be very obviously in the direction of greater accuracy without excessive added cost, for, after all, the tape measurement in experienced hands is simple and accurate too. It is easy to understand, and theoretically completely rational. As a matter of fact, gauge tape measurements are repeatable and reliable within narrow limits. The main objections to the method are that it is messy, inconvenient, and time consuming. It also, of course, involves hazards that should be avoided when possible. Likewise, the human element has its inherent weaknesses, and the overall evaluation, thus is not quite so flattering.

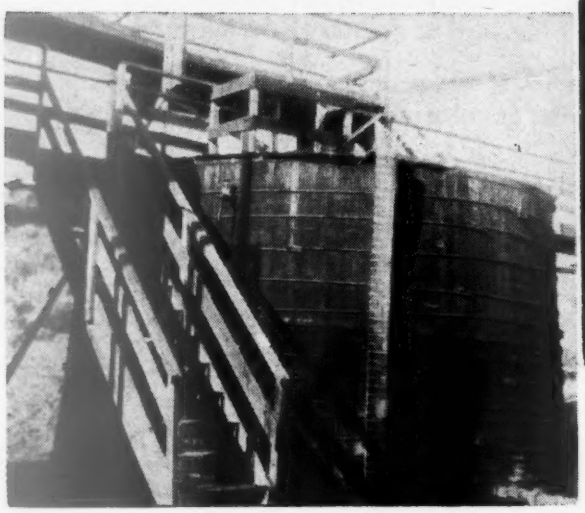
In these advanced times when methods of measurement have been developed to hitherto undreamed precision and accuracy, and many new and effective mechanisims are available for the transmission and recording of forces and effects, it seems natural that attention should be directed toward the eventual elimination of manual gauging, particularly in those operations in which contractual stipulation is not a bar to the use of automatic and mechanical devices.

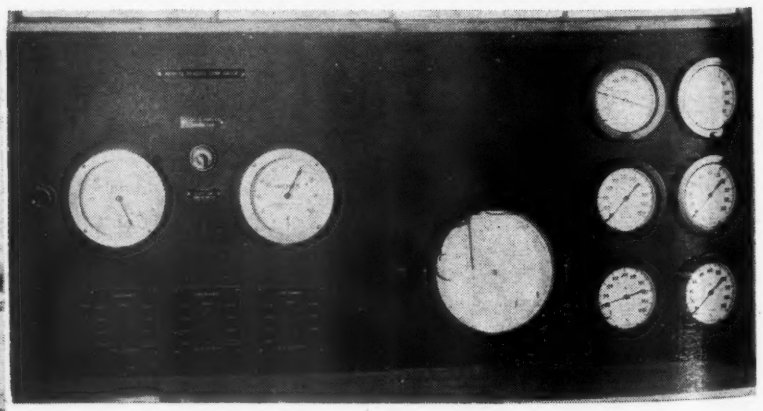
It is expensive because, for instance in pipe line or royalty gauging, each gauger must be provided not only with all the instruments and accessories that his work demands, but also with the means to transport them and himself from lease to lease and tank to tank. Besides that he can only gauge a limited number of tanks during his working hours, and if he is in a busy district must be displaced by relief men through the other tours. The gauger whose tanks are sufficiently close to headquarters to permit him to walk about the storage plant or lease is even more limited than the one with the car. Then, of course, as already mentioned, there are many hazards involved in manual gauging. The men have to climb tank ladders and stairways with their equipment; have to expose themselves often to toxic and sometimes lethal fumes or vapors: have to make their trips regardless of the inclemency of the weather, and have to face these same hazards, highly accentuated, in the darkness of the afternoon and graveyard tours.

It should be noted further that the oil line on a gauge tape may be rather

*Chief Gauger, Union Oil Company of California.

Ancient type of float automatic gauge devised by lease personnel. This installation was made in 1910 and is in use today.





Instrument panel, double selsyn motor type remote reading tank gauge. With this arrangement, which is "selective" a spot gauge on any one of 24 tanks or a continuous gauge on a working tank can be taken.

Now Press a Button

Get an Accurate Tank Reading Electronically

The S.&J. push-button Receiving Cabinet will accommodate up to 12 tanks. Note large reading dial with large triangular pointers and double hairlines to eliminate parallax errors.

The new Shand & Jurs Electronic Precision Remote Reading Tank Gauge System will gauge your tanks accurately to one-eighth of an inch, from 0′ to 50′. This system employs standard S.&J. Automatic Tank Gauges adaptable for use on all types of storage tanks, both low and high pressure. The heart of the system is the Brown* "Continuous Balance" Electronik Precision Indicator which utilizes the balanced Wheatstone Bridge principle. In the S.&J. installation a pair of 1000 ohm potentiometers is used in the transmitter.

This new system uses a 110V A.C. source, reduced to 6.3V for energizing the measuring circuit. The low voltage used puts this system in the class of communications equipment, and permits the use of small gauge wire. It presents no new circuits or complicated electrical mechanism to worry personnel. Only four leads are required for each tank, and there are no field relays or junction boxes needed, as each transmitter is directly connected to the receiver. Low initial cost of equipment, field wiring and installation make S.&J. Electronic Precision Tank Gauging more economical than the selsyn or stepping type systems.

The S.&J. Reading Cabinet for use with Key Switch system.

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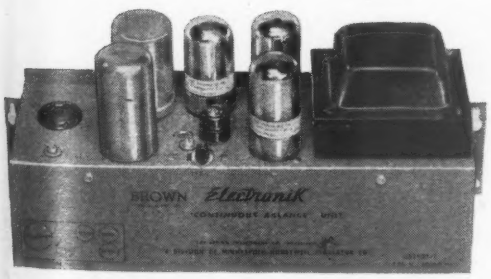
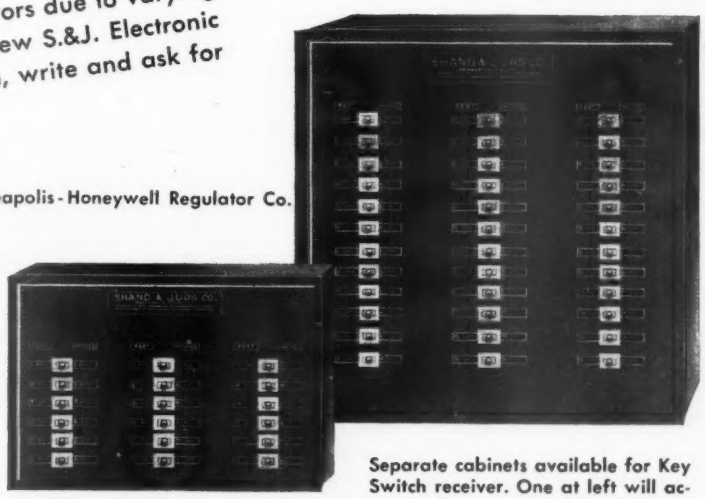
* Brown Instrument Div., Minneapolis-Honeywell Regulator Co.



The Brown* "Continuous Balance" Electronik Precision Unit which makes possible the extremely accurate tank gauging of the S.&J. Electronic Remote Gauging.



Separate cabinets available for Key Switch receiver. One at left will accommodate up to 18 tanks; that above, up to 60 tanks.

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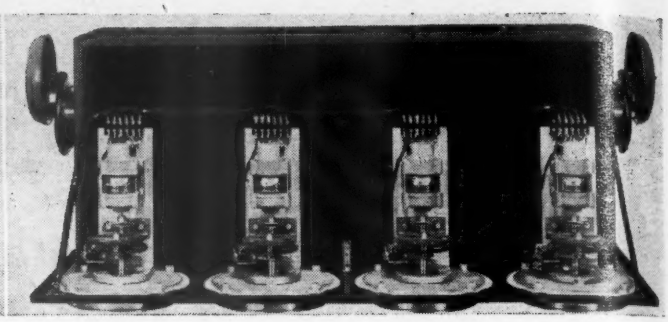
Instrument panel, showing gauge dials on a 4-tank unit, using the single selsyn motor system of remote gauging. This system provides a continuous reading on each tank.



Selsyn motor receiver assembly for a 4-tank unit, using the single selsyn motor "non-selective" type remote reading tank gauge.

difficult to define at night time, and even in daylight hours, when light or clear oils are being measured, the process requires keen powers of observation, and not infrequently some sort of artificial aid, such as powdered chalk paste or dark grease to emphasize the reading. There has been virtually no difference in manual gauging technique since it was originally initiated in the industry. Mostly such changes as have taken place have been refinements in the tankage itself and the equipment employed.

The steel tape-and-bob is probably a descendant of the old gauging pole, which was once a much more popular device. For "pay" gauging, however, it has been almost completely abandoned. One of the reasons is that in heavy oil it had a tendency to take on successive layers of crude until the markings on it were no longer determinable, and eventually it couldn't be lifted out of the gauge hatch with anything short of a steam winch. At this stage, also, wiping became more of a project than a process, and to top off the objections the stick wore on the bottom, so even when it was readable it was inaccurate—a heinous offense in the gauging department. It was even more messy than tape gauging and it is doubtful whether any tears were shed when it was tossed into the discard.

Gaugers and pumpers have been trying for a long time to find some species of automatic device for registering tank levels. In the early days when the district gauger made his rounds with a horse and buggy, he used to carry a pocket full of rocks, one of which he would throw at each shipping tank, and he could tell by the sound whether the tank was full or empty. Later he made an arrangement with the lease pumper to fly a flag at the top of the tank stairway or some other prominent place when a tank was ready to ship. All this, of course, was before telephones, and subsequently radios, made visual signs unnecessary. All, too, was an indication of the desire to cut down non-essential effort and reduce the gauging process to a more economically sound and sensible basis.

The first device that permitted determination of oil level in the tank without going on the roof was a crude automatic float attached to a wire with a counterweight on the other end. This has undergone considerable refinement since its inception, but the common types are still simple enough that they need no description here. It immediately instituted a saving in the man-power required to gather tank level records; elminated exposure to vapors from the several vents on the tank roofs, and accomplished these things at a very nominal cost. It will be recognized, of course, that for the gauger who was obliged to go to the top of the tank to procure samples, ascertain temperatures, etc., the benefits here defined were not available. But, for the balancing of shipping and receiving tanks in storage farms, for the filling of lines, and for the taking of inventories, an effective ground level gauging system is a good time, effort, and money saver.

It was only to be expected that the crude floats that were first used by pipeliners and field men should, like all other processes and devices, be markedly improved as usage extended. The early specimens were operated with their most vulnerable mechanisms —the wires and sheaves—situated in the highly corrosive vapor space above the oil in the tanks. They had a habit of sticking at inopportune moments and giving the supporters of good old fashioned hand gauging something to wisecrack about. The modern automatic float is different. It employs non-corrosive alloys for those members that are exposed to oil, water, emulsion, or vapors, and is equipped with ball-bearing sheaves to cut friction to an absolute minimum. Specially fashioned slipstream floats have taken the place of the somewhat indiscriminate species that were once used, and the attached lines of stainless steel are wound on finely calibrated drums with synchronized recording apparatus. This entire assembly can, if necessary, be enclosed in gas-tight housings.

From the obtaining of accurate readings at ground level on individual tanks, the next ambition was to transmit readings or recordings to some centrally located and easily accessible spot, for instance, the pumphouse. Several systems have been devised to perform this function, both electrically and by means of air pressure. Most of these were only perfected after long study and experimentation both by design engineers in manufacturing companies and gauging specialists within the oil companies. In the main they do the job well.

One electrical system, for instance, follows pretty closely the improvements in material quality and float design already outlined, and utilizes a drive gear on the ground level dial drum to operate a transmitter. Around the operating cam on the transmitter unit are three equi-spaced open-and-close switches. As these switches are actuated by changes in the liquid level, in turn they energize the coils on a receiving motor, which may be any distance away, causing the rotor to move radially. This movement is translated into increments of depth or volume as necessary on the dial face. It may also be provided with a precautionary accessory that, in the event of a power shut-off, locks the gauging system, and when the power comes on again assures the operator that the transmitting and receiving units will be automatically in synchronization. Incidentally, the system operates on a standard 110-volt, 50-60-cycle light circuit, which is required only at the receiver.

Another effective system employs for individual tanks one selsyn motor

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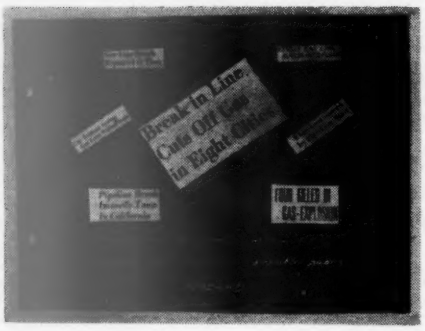

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as a transmitter and one as a receiver. The transmitter is positioned by a sprocket assembly by precision perforations in a stainless steel graduated tape, as the float rises and falls with changing liquid level. The transmitter actually operates as a generator while the receiving unit is operated as a motor. The secondary windings of the two selsyns are connected. Thus, when the primary excitation circuit is closed, an a-c voltage is impressed on the primary of both transmitter and receiver. As the rotor on the receiver is free to turn, it assumes a position similar to that of the transmitter, and follows every change, indeed, at the same speed and in the same direction. Again this rotary motion is translated into tank depths in suitable increments, and the method in general is applicable and eminently satisfactory for installations involving just a few tanks.

There is an expansion of the foregoing system also that has been applied widely and effectively. In this two selsyns are used at each tank for transmission, and they are operated in connection with a selector switch that permits successive gauging of multiples of tanks at a remotely situated receiver panel. The recording mechanisms in these systems are so precisely built that they are accurate to well within the ⅛-in. increment that is the standard limit of accuracy in most tank gauging.

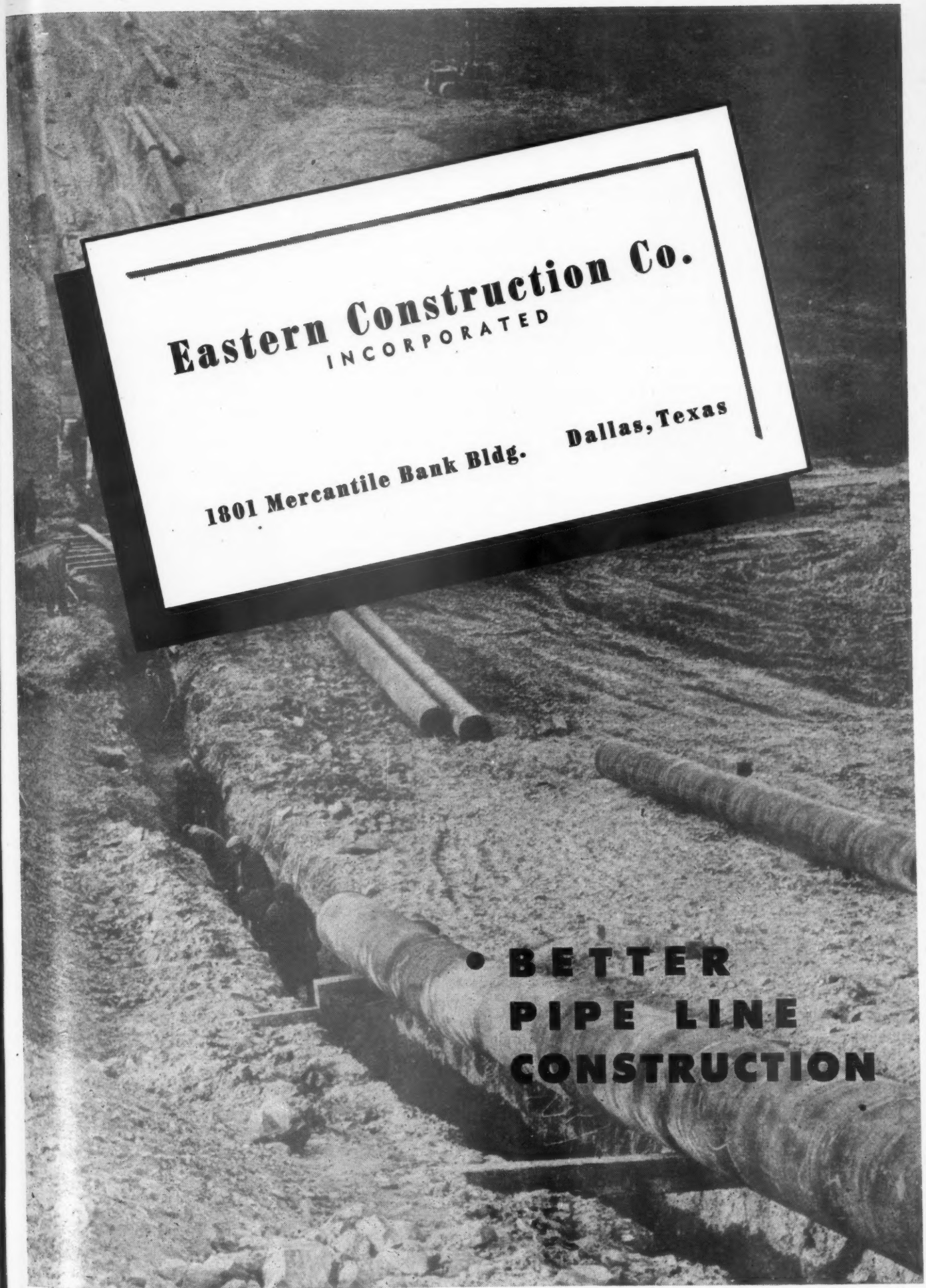
The writer has had experience with several such installations, one of which, indeed, is the largest in the west, and perhaps the largest in the world. It permits the remote gauging of some 24 tanks, with a combined capacity of more than 2,000,000 bbl of oil. The manual measurement of this battery, as can be well imagined, is a sizable task, but with double selsyn motor transmitters and a selector panel, it can be done in a few minutes at any time and the engineer doesn't need to step outside the pumphouse. Another advantage is that all tanks can be gauged almost simultaneously, whereas with manual gauging there is a considerable time lag between gauges.

The automatic gauger, remotely controlled, has also been used to advantage at pump stations along the pipe lines where it gives an immediate check on station storage and on pumping rates both in and out of the stations. Similarly, it is most convenient for measuring line fills, clearances, displacements, and for other common operations, not the least important of which is the blending of petroleum products. Among the substantial recommendations, thus, for any reliable system of remote control gauging is that it conserves labor and permits more effective use of the available labor.

The mechanisms employed in the installations referred to are rugged and dependable. They will give accurate readings, and normally only require minor adjustments with a significant change in the gravity of the oil being handled. Friction in the float has been virtually eliminated, and the float itself has been greatly improved through experimentation and experience. At one tank farm equipped with remote control gauging recently a blend of gas oil and heavy base stock was accomplished satisfactorily, and in good time, by one gauger. This operation, involving the proportioning of the commodities, the adjustment of pumping rates, and the thorough mixing by circulation, would ordinarily have required three gaugers. With the remote gauging panel placed in the pumphouse, however, it was a comparatively simple operation for one individual. Again, it might be noted that at one-man stations it obviates the necessity of the engineer leaving his equipment running while he goes out to the yard to check gauges.

Automatic gauging devices, whether remotely controlled or otherwise, are not yet acceptable for the measurement of purchase or royalty oil. As intimated in the beginning, this in some instances at least is because contractual stipulation prohibits the use of anything other than tape gauges, and in most other cases the prohibition is the result of custom and practice. It seems rather likely, as temperature and water content can be remotely determined, that the restless scientists are not going to be long content without remote readings on gravity. When the time comes that all these things can be tied in together, the operator will be driven to the use of remote gauging even for purchase and royalty oil.

Meantime the process of gauging at a distance seems to be well advanced and the systems already devised are in the main doing excellent work, particularly in the taking of stock inventories and in such other pipe line operations, as have already been cited. The type to be used depends on circumstance. There are a number of different varieties on the market, including a recently developed electronic system. The measurement engineer who expresses interest will find no lack of help in his effort to decide which one to use, and having chosen the right one for his particular problem, will find it an excellent medium for the simplification of many normally tedious operations. ★ ★ ★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PIPE LINE
CONSTRUCTION

Welding on Products Line in Service

L. J. BERNARD, C. C. McROY, J. N. STEPHENS, A. B. HANNAH

As an introduction, let us review the old familiar triangle that has been used so often to explain how fires and explosions take place. The same components must be taken into consideration when setting up safe welding procedures on products pipe lines. The welding operations generate the heat; the work is done in the open or even worse in a bell hole, and the product in the line could supply the fuel if allowed to escape and form vapors. Everything is there to form an explosion if the three can get together. With product moving in the line, the heat produced in welding is being continuously dissipated, thus in pipe line welding all we have to do is to see that no explosive vapors are present and to take all precautions to see that they are not likely to become present. Regarding the latter every precaution must be taken. This calls for preliminary procedures that are general for any welding work on the line. They are:

1. Only experienced supervisors, welders, and welders' helpers are used on this type of work.

2. Only electric arc welding is used. (In gas welding you have to heat to the melting point of the parent metal in order to fuse the steel together and to heat pipe to melting temperature under pressure would possibly cause a line blowout.) Welding is never attempted on a products pipe line unless there is a sufficient flow of products to dissipate the heat being produced.

3. Excavations for repairs to underground lines should provide plenty of room for the welder to work freely and to allow a quick exit in case of emergency. The supervisor will determine whether bracing is needed to prevent cave-ins and, with the welder, decide whether it is necssary for harness and ropes to be worn by the men in the hole.

4. The chief dispatcher must be notified and given full details regarding any work on the pipe. This will include such information as location, estimated time required to do the work, nature of the work, etc. The dispatcher, in turn, will arrange pumping operations to suit conditions as described by the welding supervisor. He will advise adjoining stations to be on the alert for pressure drops, advise the welding supervisor regarding product in line at the work location and the time welding can begin. He will not permit welding on the line if there is a scraper in the line between the station pumping and the take-off point.

5. Portable two-way radios are used if welding is to be done on the main line. One radio is set up at the work location and the other at an adjacent station, preferably the up-stream station. This permits rapid communication to all parties involved and allows operations to be changed rapidly to suit prevailing conditions.

6. Automotive equipment, generating light plants, welding equipment, and any other equipment that could produce a fire are parked on the windward side of the pipe line at a safe distance (200 ft minimum) and preferably on higher ground if possible; always far enough away to avoid the possibility of explosive vapors.

7. Fire extinguishers (CO_2), first aid kits, extra clothing, etc., are made available. Coffee and food will be supplied as conditions require.

8. If welding is to be done near a highway, suitable warnings will be established for traffic safety. If near a railroad, the officials will be notified of the work so they may take the necessary precautions.

9. Residents in the vicinity are advised of the work and their cooperation requested in the taking of necessary precaution. These will be outlined by the supervisor in charge.

10. Prior to lighting torch or doing any welding, everyone on the job will be called together and briefed by the supervisor on the safety precautions that will be observed and what each will do in case of fire or accident.

11. In case of leaks or breaks the bell-hole and surrounding area will be gas freed and tested. Tests are made with a gas indicator and as a final precaution with a lighted torch after the gas indicator shows conditions satisfactory for welding. Only after the area has been checked and found free of gas and dispatching has given approval will welding be permitted.

EXCLUSIVE

The Authors

Luther J. Bernard joined the Great Lakes Pipe Line Company in 1939 as an assistant engineer, and in December of 1941 he went to work for Plantation Pipe Line Company as a station operator. In less than a year, he was promoted to station chief. He entered the line maintenance operations of the company in 1946 and is now line foreman of Plantation's Eastern division.

Clifton C. McRoy worked for the state of Mississippi and the city of Meridian in construction engineering, soil erosion, and survey work until 1941, when he joined Ford, Bacon and Davis. In 1945, after two years with the Navy Sea Bees he went to work for Plantation Pipe Line Company. At present he is line foreman of the company's Western division with headquarters at Baton Rouge, Louisiana.

James N. Stephens, a native of Arkansas, began work in 1926 with Williams Brothers, Tulsa, Oklahoma. He left them in 1942 and joined Plantation, working as a mechanic and a welder. In 1947, he was promoted to line foreman of the Pipe Line's Central division at Bremen, Georgia.

Archer B. Hannah was graduated from Virginia Military Institute, with a civil engineering degree. He went to work for Esso Marketers in New York in 1935, and in 1936, transferred to one of the Latin American affiliates of Standard Oil (New Jersey) and remained in foreign service until he entered the Army in 1942. After the war, he returned to Venezuela with Creole as merchandising assistant. In 1947, he went to Plantation Pipe Line Company. He is supervisor of training and safety and manager of public relations.

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Another important precaution is to have the bell-hole free of moisture to prevent the possibility of an electrical shock from a faulty welding machine cable.

12. When preliminaries are satisfactorily concluded, welding may begin.

Type of Repairs

The condition of the pipe will determine what types of welding repairs are required. It is always advisable that the welder check the heat from his welding machine by running a practice bead on a sample piece of pipe of the same thickness and classification to determine whether the depth of penetration of his arc is satisfactory. The maximum size rods used for the first bead are $\frac{5}{32}$-in. Fleetweld No. 5. The reason for this is: Should a larger rod be used on the first bead it will require high amperage and later, if a smaller rod is used to finish the job, the machine may accidentally be overlooked and not readjusted for lower amperage. This may result in a hole being burned through the pipe. The remaining beads are made with $\frac{3}{16}$-in. Fleetweld No. 5 rods. The welding machine is regulated to approximately 100 to 150 amp and 5 to 10 volts.

Down-hill (down-hand) welding is advisable on a products pipe line on the first pass as less heat will be produced.

The experienced welder will check continuously during welding operations to see that the heat is being dissipated satisfactorily. This is done by the welder placing his hand approximately 8 to 10 in. from the weld on the down stream side and, if the pipe remains cool, he knows product is flowing and conditions are satisfactory. Should the pipe at that point continue to heat up he will stop welding and determine the cause. Welding may begin after necessary changes have been made.

Regular maintenance of pipe lines require a continuous search for "hot-spots" (sections of the pipe where excessive corrosion has taken place). In repairing "hot-spots" the line is stripped and then cleaned with a wire brush until approximately 100 ft of pipe without pitting is uncovered. When the limits of the "hot-spots" have been established, all the pit holes to be welded are cleaned and marked for the indicated type of repairs. The pit holes are first checked with a pit gauge. If the depth of the hole is less than one-half the thickness of the pipe, after it has been cleaned with a chip hammer and wire brush, then spot welding is indicated. There must be a minimum of 130 mils of good uncorroded steel left in the wall of the pipe before spot welding can be considered safe. The holes to be spot welded are circled with white chalk. Holes deeper than mentioned above are circled with red chalk. Extreme care must be taken in cleaning the deeper holes to avoid puncturing the pipe. The supervisor will see that all pit hole cleaning is done no closer than 200 ft from any welding operations. If the deeper pit holes can be cleaned, and are not too excessive, they may be patch welded. If the corroded area is too extensive for patch welding, then slab welding or half soling may be indicated or, in extreme cases such as 200 ft or more of badly corroded pipe, consideration will be given to replacing the section.

The various methods of repairs are described hereunder.

Spot Welding

Spot welding consists of running a bead over the hole, thus sealing it. The bead must *not* be put directly in the hole as excessive heat may result in penetrating the wall of the pipe. The bead is started a little distance back from the edge and brought up across the hole. Spot welding should never be done over an old weld as the old beads may contain "bird-eyes," i.e., pin holes in the bead and thus have

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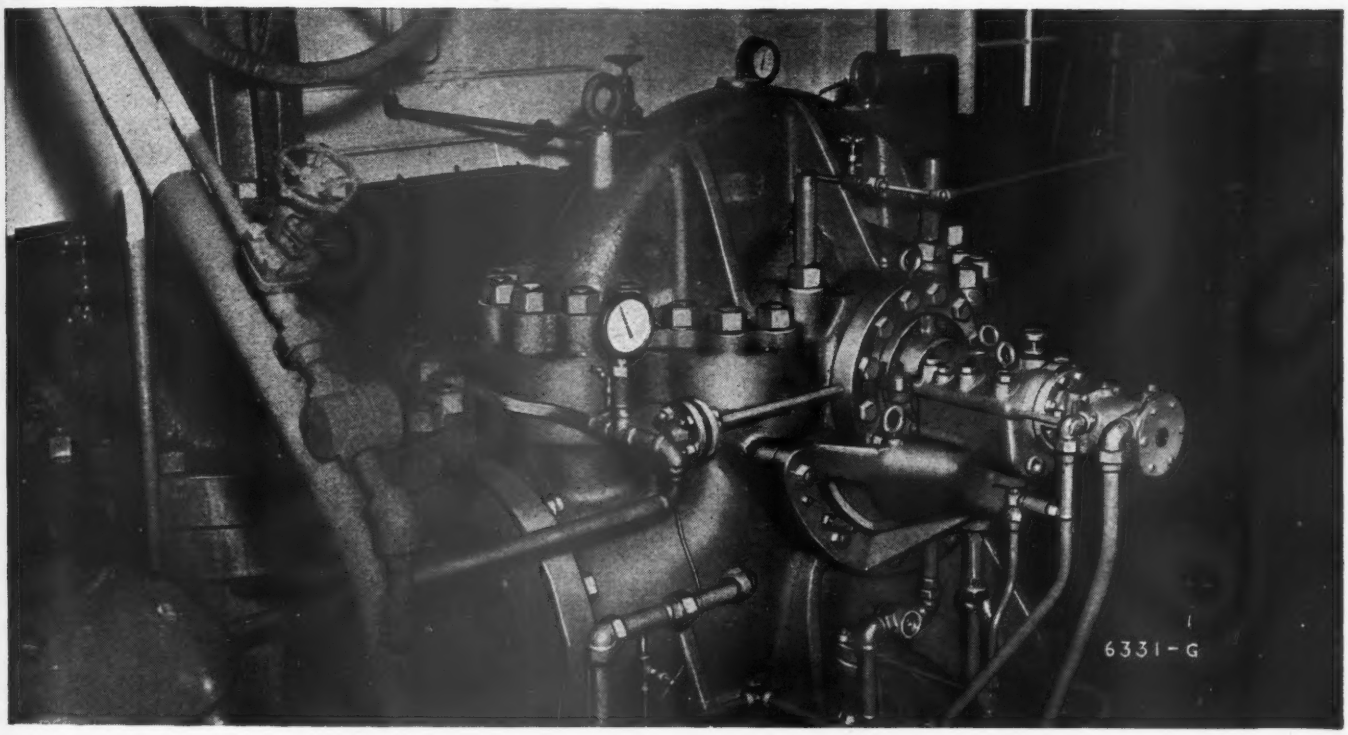

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C-12

little actual thickness even though appearing to be satisfactory.

Patch Welding

Patch welding consists of welding steel disks, 3 to 4 in. in diam and of the same classification as the pipe, over the cleaned hole. Should the patch cover a spot where welding would have to be done on a welded joint or a previous spot weld, then a slab or half sole would be indicated. One or the other would also be indicated if the pit holes were too numerous for patch welding.

Half Soling

Slab or half sole repairs consist of welding new steel of same classification and rolled to fit the pipe over the pit holes. The slab or half sole should cover adequately the cleaned corrosion pit holes. A slab is considered ¼-section pipe and the half sole ½-section pipe. The plate is clamped over the holes with U-clamps and tack-welded in place. The clamps are then removed and the plate lap-welded. No welding is done over previous welds for the reason stated above.

In all the above operations welding is only done when there is a sufficient flow of product in the line to carry off the heat being produced by the welding operations. Experience has shown that a flow of approximately 5 in. per second will do this. For the size lines as indicated, the following minimum rates of flow are maintained during welding operations on Plantation's product pipe line:

12 in. line—200 bbl per hr
10 in. line—140 bbl per hr
8 in. line— 90 bbl per hr
4 in. line— 25 bbl per hr

Pin Hole Leaks

Pin hole leaks are repaired as follows: A section of heavy Gro-Cord rubber gasket is cut to extend 1½ to 2 in. around the outer boundaries of the pitted area. A patch having the same classification as the pipe is cut to cover approximately 2 in. beyond the boundaries of the gasket. The patch is then bolted with U-clamp over the gasket that covers the hole. One clamp should be over the hole and, if the patch is large enough, additional clamps applied. All patches and gaskets should have rounded corners. The clamps are tightened until there is no leakage under maximum pumping pressures. The line is then returned to service and the work of gas-freeing the area begins. When conditions are safe, welding is done as previously described.

Leaks or breaks require considerable work to be done prior to the time any welding operations can begin. As soon as leakage is apparent the line is shut down and the location determined. Block valves that can help lessen the loss are closed and means of trapping the product are constructed. Pin hole leaks may be repaired as previously described.

Line Breaks

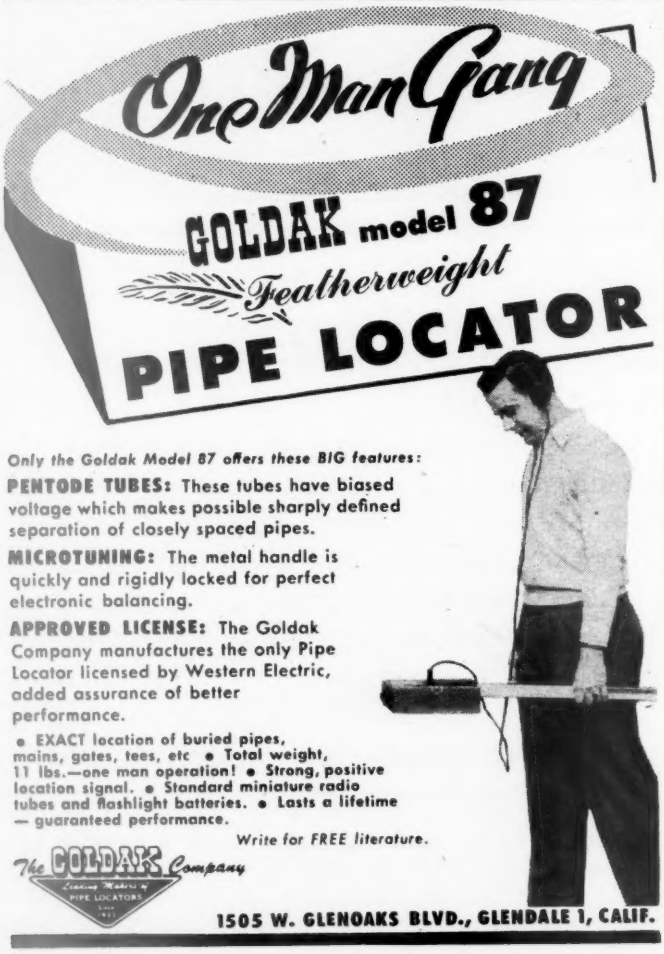
Line breaks are more complicated and require the assistance of every available man. The line is shut-down and suction pumps at adjacent stations are run. Gate valves that will help stop the flow are closed. Traps are constructed to catch the escaping product. Men scout the lowlands to trap product that may cause damage and to take other necessary precautions. All traffic is controlled. When the break is located, the line is stripped approximately 250 ft on both sides of the break to give plenty of slack. This prevents the ends from jamming when cut and possibly causing a spark. Also, by stripping back this far tripods can be set some 30 to 40 ft away from where the cut-ins will be made so that the line can be raised, thus lessening the shock when cut.

Prior to cutting the pipe, a bonding cable shall be connected to the line around the defective section to be removed. Only mechanical cutters are used to cut out the pipe. The cutting blades are kept oiled to eliminate the possibility of sparks. A welding torch is never used for cutting pipe from lines in service.

Sufficient pipe is removed to determine the cause of the break and to determine whether there are flaws in other sections.

As soon as pipe is cut and removed the ends of the pipe are cleaned with the appropriate spark-proof equipment. The new section is inserted and Rola-Grip rubber gaskets installed. These gaskets are previously oiled as an aid in preventing pinching. They are then slipped on the ends of the pipe using soap stone markings to locate the gaskets equidistant over the joints. The Rola-Grips are then placed over these gaskets and care is taken to see that both sides of each Rola-Grip is tightened uniformly. A spark-proof hammer is used to warm up both sides by tapping the metal so that the Rola-Grips will set firmly. When the line has received these temporary repairs, dispatching is notified and the line pressured for leaks. The repairs must withstand maximum normal line pressure without leaks or gas fumes.

After the area has been gas freed, half wraps can be installed over the rubber gaskets and welded into place. The half wraps are fabricated in two segments. They fit over the couplings and have short aprons that fit snugly around the pipe and, in addition, has a 2-in. coupling welded to each segment. After the half wraps have been welded together and to the pipe, the interior is filled with neat cement through the top 2-in. pipe coupling, the bottom one, of course, having been plugged previously. The cement is firmly tamped inside the half wrap to eliminate air pockets. When the interior is full a plug is screwed into the top coupling. The line is now ready to be lowered into the trench, backfilled, and normal operations resumed. * * *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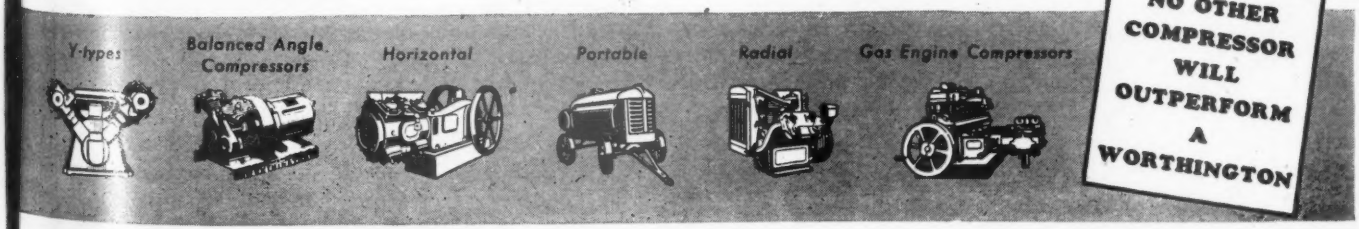

Dispatching a Long Gas Transmission Pipe Line

THOS. B. KELLEY

The Author

Thos. B. Kelley is superintendent of dispatching, Texas Eastern Transmission Corporation, Shreveport, Louisiana. He was born May 23, 1905, in Kirbyville, Texas. After finishing at Kirbyville High School in 1924, he entered the employment of the Gulf Colorado and Santa Fe Railroad Company and worked as telegraph operator and agent until 1929, when he left the Santa Fe for employment as a gas dispatcher for Magnolia Gas Company of Dallas, one of the predecessor companies of United Gas Pipe Line Company. He remained with United as field and general office dispatcher until April, 1947, at which time he accepted his present position with Texas Eastern.

THE dispatching department on a natural gas pipe line system might well be compared to the nerve system of the human body, in that it controls the impulses that affect the flow of gas through the system. When the hourly "OS" reports come in, the dispatcher has a complete picture of the lines from end to end so that he can readily determine whether any changes are needed to improve the operation of the system.

The operation of a long gas transmission pipe line system is different in many respect from that of a more compact "short haul" system. Of primary importance is the fact that the total storage of the system is contained in one continuous line, which must be handled as one unit, careful balance being kept between field intakes and deliveries from the line. The storage in a long line is equal to several days' capacity of the line and can be used to advantage at times, depending on pressures required and other characteristics of the system.

The Texas Eastern Transmission Corporation system is designed to operate on a very high load factor and, consequently, little standby horsepower is installed. From a dispatching viewpoint, this creates a problem when an interruption occurs, as the dispatchers must immediately ascertain the best method of using this standby.

Compressors

On the "Big Inch" and "Little Big Inch" pipe lines, we have installed in compressor stations approximately 275,000 hp. Approximately one-third of this horsepower is made up of 1000-hp gas-engine-driven reciprocating compressors and two-thirds is composed of electric-motor-driven centrifugal compressors. This represents the first successful large scale installation of centrifugal compressors on a gas transmission line. Our success, however, has not been achieved without the usual "growing pains" accompanying the development of a new machine. Many of our troubles arose in connection with the difference in operating charactertistics of centrifugals from the reciprocating machines. The only method of controlling the load on an induction motor-driven centrifugal compressor is by careful adjustment of the suction line valve and great care must be taken not to waste power during normal operation by throttling unnecessarily or to establish a high electric energy demand by opening this throttle valve too quickly during a "pack" transferring operation. The centrifugal compressor is capable of handling enormous volumes of gas when the stage compression ratio is lower than normal, consequently overloading the prime mover.

There are nine angle type reciprocating compressor stations operating, at present, on the "Inch" lines. As the average distance between compressor stations on this system is slightly more than 50 miles, this tends to keep the station compression ratios well below 2. One station, in fact, usually operates at a ratio of less than 1.4. These stations are generally more flexible in their operation, in regard to prime mover load and speed, than are the centrifugal stations, and following a pipe line or station failure the dispatching department tends to load these stations as heavily as they can, consistent with good operating practice and engine care. As gas engines can be overloaded for short periods, and since there is no possibility of establishing a high electric demand charge, it is logical that the engine stations should carry the brunt of the load following any emergency shutdowns. One disadvantage we have found in designing reciprocating compressors for low compression ratio operation has been in obtaining sufficient clearance volume to unload the compressor ends at times when an abnormally high ratio is required. This problem, however, is being worked out by installing larger cylinders than necessary and the building of extra clearance into the cylinder design by the manufacturers.

Good communications are essential to efficient dispatching. A "party line" circuit connecting all dispatching points and compressor and regulating stations is the method now being used by our company. This circuit is immediately available to the dispatchers at all times, but when it is not in use for this purpose it is available for other company calls.

Converting Lines

As the "Big Inch" and "Little Big Inch" lines were built and operated as oil and products lines during the war, it was necessary to make numerous changes in converting them for the transmission of natural gas. Considerable internal cleaning was also necessary to bring the efficiencies of the lines up to normal gas operation. This cleaning has been accomplished by using the original incoming and outgoing scraper traps at each of the stations, and running brush and rubber cup type scrapers through the lines during normal operations. This is done much the same as in liquid lines, with the velocity of the gas moving the "pig". This overall cleaning process of our lines was probably a little slower than "open end" runs, but since no shut downs or interruptions were necessary, it has been done at far lesser expense.

Maintaining Quality

The best method of keeping the lines' efficiencies up after they have been cleaned is to keep foreign matter out. The dispatching and measurement departments, through the field measurement engineer, are constantly checking the "quality" of the gas. Routine periodic quality measurements are

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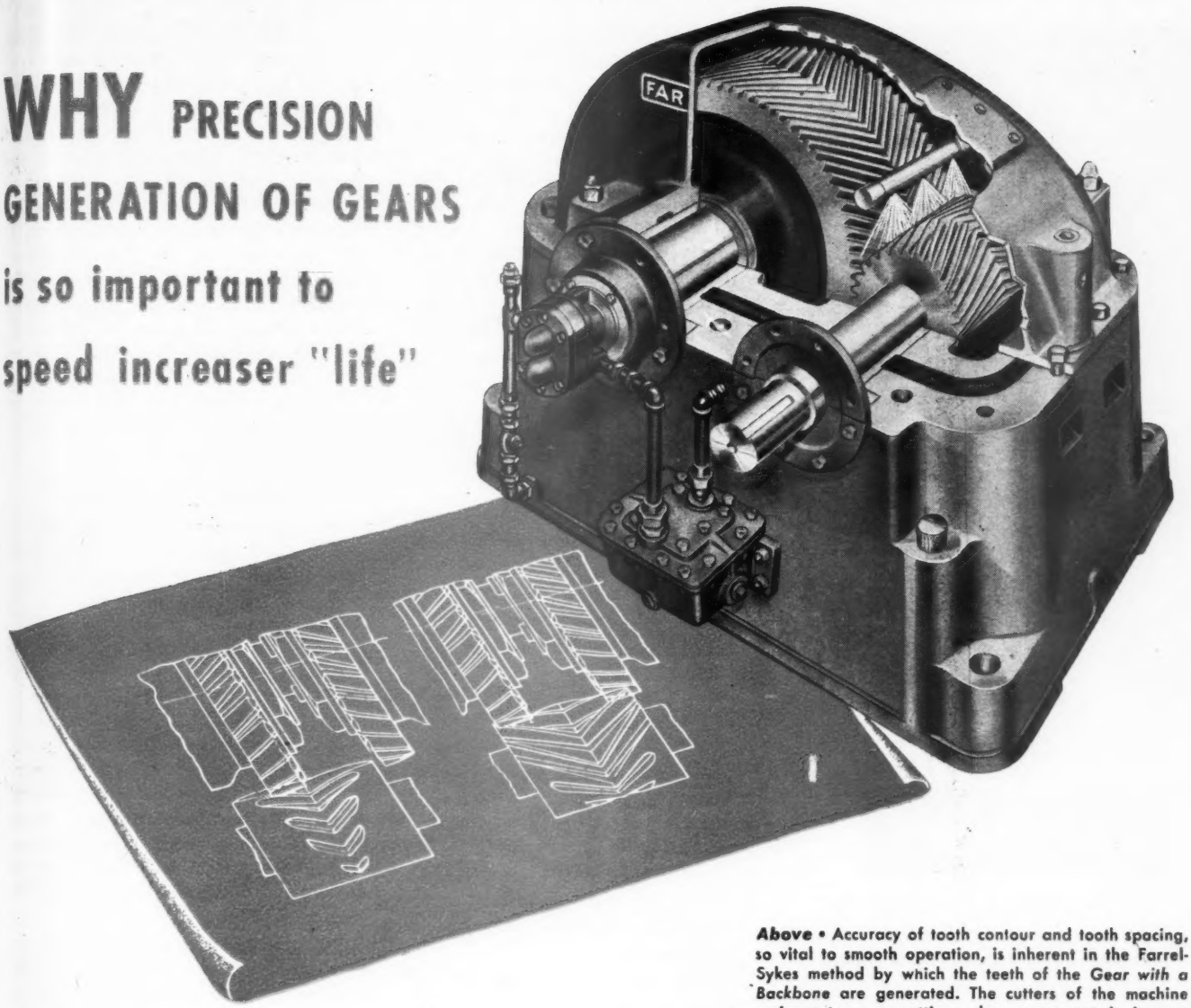

Above • Accuracy of tooth contour and tooth spacing, so vital to smooth operation, is inherent in the Farrel-Sykes method by which the teeth of the *Gear with a Backbone* are generated. The cutters of the machine reciprocate, one cutting when movement is in one direction and the other when the movement is reversed. Each ends its stroke at the center of the blank. As they cut, they twist to generate the helices and also slowly revolve in unison with the gear blank to generate the tooth contours precisely.

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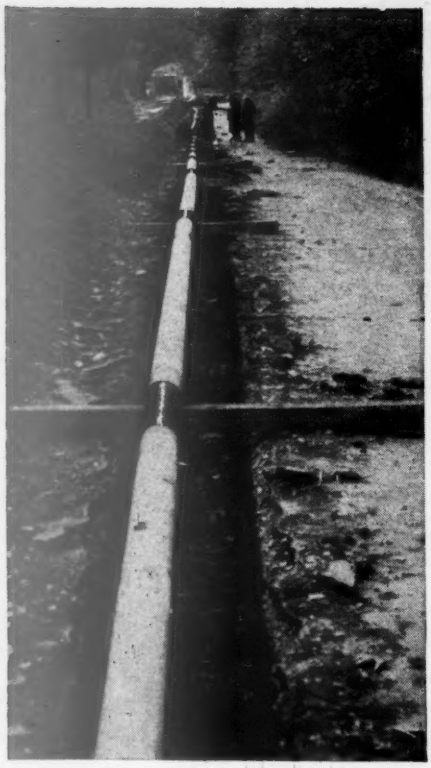

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made in the field by measurement engineers and written reports of all tests and inspections are mailed to the measurement department, general office. Handling of all unusual circumstances concerning the quality of the gas is coordinated by a general office gas engineer assigned to quality control and related measurements. All "off quality" findings are reported through the dispatchers to expedite handling.

Our gas purchase contracts require that gas delivered into our lines meet the following standards of quality:

1. Shall contain 1000 Btu or more per cu ft.
2. Shall contain not more than 7 lb of water vapor per 1,000,000 cu ft.
3. Shall contain not more than 1 grain of hydrogen sulfide and not more than 20 grains of total sulphur per 100 cu ft.
4. Shall not contain in excess of:
   (a) 3 per cent by volume carbon dioxide.
   (b) 1 per cent by volume oxygen and
   (c) 0.2 gpm gasoline content.

By determining that the gas meets these standards of quality, we are sure of being free of stoppage or restrictions in our facilities or in the facilities of our customers due to:

1. *Gas hydrate formations.*
2. *Heavy deposits of water or liquid hydrocarbon.*
3. *Chemical corrosion due to hydrogen sulfide and carbon dioxide.*

One of the most important "qualities" that has to be controlled is that of water content. If a modern high pressure pipe line system is to operate successfully in the winter and overcome hydrate stoppages a dry gas must be purchased. The results of regular daily water vapor content tests conducted by operating personnel at compressor stations along the pipe line are reported to dispatching department personnel by company phone and they, in turn, report any increase in water content to the measurement department for further investigation. If investigation by the gas engineer proves that the water content of the gas coming from any certain supplier is more than 7 lb per 1,000,000 cu ft, the dispatchers will immediately reduce the rate of gas take from the offending supplier until the reason for the high water content can be determined and eliminated.

Purchase Contracts

The gas purchase contracts stipulate that the gas purchased shall not have greater than 0.2 gal of natural gasoline per 1000 cu ft as determined by the NGAA Standard Charcoal Test. This provision is included to eliminate the nuisance involved and the loss in pipe line efficiency due to condensation of heavy hydrocarbons in the transmission lines. Due to the fact that the heavier hydrocarbons are worth more as gasoline than as natural gas, most of our gas suppliers extract as many of the hydrocarbons as possible before selling the gas to us. Therefore, we are only occasionally troubled on this score.

To combat chemical corrosion, the hydrogen sulfide, carbon dioxide, and oxygen provisions have been placed in the gas purchase contracts. The carbon dioxide and oxygen determinations are made by annual laboratory analyses of the gas purchased. The hydrogen sulfide tests are made regularly by the field measurement engineers using 5 per cent lead acetate solution on filter paper.

After the daily dispatching sheet has been completed much data are contained thereon. Much of this is used for calculating pipe line and compressor station efficiencies, volume in storage, electric power demands, daily field inputs, total sales and even estimates of company earnings. All this brings a dispatcher in close contact with all phases of the operating department and by cooperating with all of them, and receiving their cooperation in return, a smooth working team results.

Every shift a dispatcher will have some new problem arise, but with his experience he will know the effect his decision will have on the overall operation of his system. If he makes a mistake he will be first to realize it and the one to benefit by it, if that old adage is true. * * *

1000 Miles per Gallon

From coast to coast, gasoline is available for the nation's 41 million passenger cars, trucks, and buses. Yet probably few persons realize that the average gallon must be transported at least 1000 miles before it reaches an automobile tank. Pipe lines, trucks, barges, and frequently tankers are involved in this trip. Another fact that escapes normal attention is that most crude oil is produced, refined into gasoline, and transported to service stations without ever being seen by man.

—*API Newsnotes.*

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Many years were needed to build this service organization of 83 Buckeye Dealers . . . because such an organization has to be much more than a list of names. Each company must be of proven reliability . . . have the experience, the equipment, the trained staff and the local parts stock to be really helpful to all users of Buckeye Ditchers in the territory. Each dealer must also appreciate the opportunity for continuous improvement in his service and work in that direction. The Buckeye Service Organization is a known quantity . . . known for giving service that helps you get "the most ditch for the least money."

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Good Pipe Line Warehousing Practice

L. W. EWING, JR.

THE geographic spread of pipe lines in sprawling networks across the United States has caused a variety of unusual problems to be solved by the petroleum industry. A recent survey of pipe lines to transport crude oils, petroleum products, and natural gas reveals that the total mileage of pipe lines now exceeds that of railroads, which is a sobering indication of the rapid strides taken by oil men to meet a growing demand for rapid and economical transportation.

Considerable publicity and attention is given to the planning, financing, and construction of the industries' pipe line facilities, but the solution to the problem of maintaining plant facilities and machinery of such far flung pipe lines infrequently receives attention. For the most part, this problem is solved by the management group of each pipe line company in a manner that best suits their individual requirements. Although the system adopted by the Products Pipe Line Department, Standard Oil Company (Indiana) is not considered unique in the industry, it is believed that a review of the typical problems confronting pipe line management may be beneficial to existing operators as well as the companies now being formed.

In order to establish an efficient warehousing system to store spare parts and machinery for a pipe line, it is necessary to evaluate the means of normal transportation and communication between principal terminals and pump stations along the line. Pipe line companies are required to maintain and operate over widely separated portions of real estate connected by a strip of pipe line right-of-way a few feet wide by several thousand miles long; whereas the average industrial firm can solve its warehousing and supply problems on an orderly plot of ground where its receiving of raw materials, manufacturing of its products, and shipping to its customers all can be efficiently accomplished.

Many pipe line companies have expanded at such an accelerated rate that the warehouse facilities they once considered as central for their operations have been left far behind in the expanding system, and the operators have accordingly been required to shift their warehouse stock system from one of central distribution and control to a series of dispersed secondary warehouses. On many pipe lines a central warehouse could not be justified as a paying proposition, and this would be particularly true of individual long cross country lines. Standard Oil Company (Indiana) has experienced a similar progressive shift of warehouse facilities and, as Fig. 1 indicates, now maintains its central warehouse facilities near Rochelle, Illinois. Establishment of central warehouse facilities at this location was based on availability of highway and rail transportation as well as the company's program for expanding its products pipe line facilities to serve an increasing market territory.

The pipe line operator normally keeps a wide variey of fittings, machinery spare parts, and pipe in storage for emergency use and replacement of worn out equipment. Unfortunately, most of these items are of an irregular, bulky, non-stacking nature and challenge the skill and ability of the warehousemen to safely stock such items on a minimum floor area and still keep them accessible for ready removal. In addition, this wide variety of stock requires frequent attention to maintain coatings of paint, corrosion protective grease, exclusion of dampness, and to generally maintain the stock in its new or usable condition. This one factor alone requires that the arrangement of stock shall permit easy and occasional access to even the most clumsy and bulky items. It is difficult to establish an economical working level of material and spare parts inventory, particularly during the more recent postwar period when availability and shipment of certain parts and fittings can be quickly accomplished. Further, the accumulation of excess warehouse stocks raises tax assessments and represents a pile of inactive capital on which the operator cannot earn any investment return until the items are capitalized by being made a part of the plant facilities. Accordingly, it is difficult to convince management of the need of adequate warehouse buildings and material handling facilities, particularly inasmuch as these improvements reflect only indirect savings to the operator and cannot be normally justified by the usual payout calculations. Management is often additionally reluctant to establish a warehouse at a central location when facilities are constantly being planned that could ultimately cause its relocation.

Purchase of Materials

In order that Standard Oil Company (Indiana) may effectively oper-

The Author

L. W. Ewing, Jr., is assistant chief engineer of the Standard Oil Company (Indiana) products pipe line department, and has had a wide variety of general construction and pipe line experience. As a graduate engineer his first major job was with the United States Engineer Department where he was chief-of-party on topographic surveys and heavy construction in connection with flood control dams and military airports. Upon conclusion of this work, he was employed by the Panama Canal in 1941 as a structural designer and later assigned to an extensive wartime pipe line and terminal installation, now known as the Navy Trans-Isthmian Pipe Lines. He followed this project from its inception in both operating and engineering jobs, working progressively as design engineer, construction inspector, gauger, station engineer, survey and layout engineer, and supervising civil engineer. During most of this work Ewing was employed by the Bureau of Yards and Docks, Navy Department, and on the latter phase of work served as government member on boards of negotiation. He was co-author of an article describing this $40,000,000 project, published by the *Military Engineer*. He also directed an engineering group handling special petroleum problems and served on a joint Navy-Air Force committee to build the first pipe line system handling jet aircraft fuel on a bulk product basis.

After seven years of pipe line experience in the tropics, he was employed by Standard Oil Company (Indiana) in September, 1948, as senior engineer and was promoted to his present position in January, 1949. Ewing is an active participant in the NACE, The Society of American Military Engineers, and serves on two sub-committees of the API.

EXCLUSIVE

We Will Begin Construction

on or about April 1st of approximately
130 miles of 12" and 70 miles of 8" to 4"
gas line pipes *for*

East Tennessee Natural Gas Company

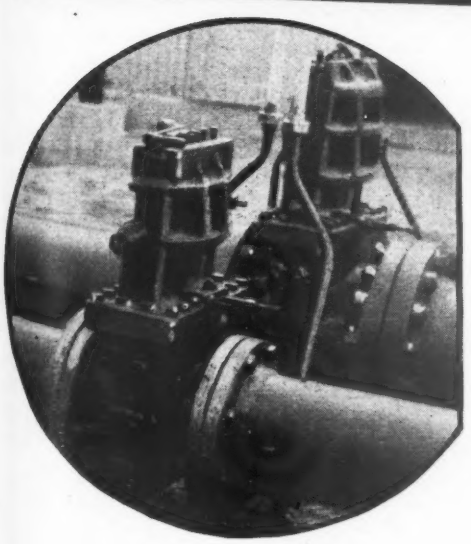
in the vicinity of Chattanooga, Tenn.

N. A. SAIGH COMPANY, INC.

531 MAJESTIC BUILDING SAN ANTONIO 5, TEXAS

PIPE LINE ENGINEERS AND CONTRACTORS FOR 29 YEARS

When you measure Use DANIEL



DANIEL ORIFICE FITTINGS

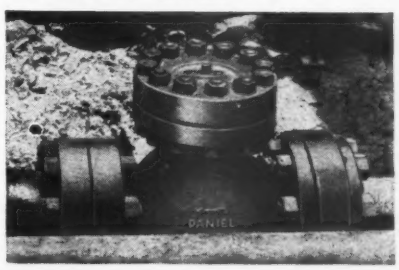
are designed and built to meet exacting demands of present day metering. Years of actual field service have proven their accuracy, dependability and trouble free operation.

Here are just a few of the outstanding advantages you get when you SPECIFY DANIEL ORIFICE FITTINGS—

• Lubricated Stainless Steel Valves • Every part can be renewed or repaired without removing from line • Bubble-type Non-Metallic Sealing Orifice Plate Units, Daniel Orifice Fittings are available in sizes from 2 to 30 inches. Pressure range 0 to 6000 lbs. C.W.P.

DANIEL PISTON CONTROLLED CHECK VALVES

are designed for high pressure service where pulsations are severe. Designed with full size port areas. Minimum pressure drop. Controlled action of the piston with correct orifice eliminates pounding or chattering. Available in sizes from 1 to 16 inches. Pressure range 300 to 2500 lbs. A. S. A.



Consult composite catalog for sizes, prices, etc., or write for your copy. Our Engineering Department is available to help you in your measurement problems. We welcome your inquiries.

DANIEL ORIFICE FITTING CO.

LOS ANGELES • TULSA • FORT WORTH • HOUSTON

Agents in Principal Cities

ate its products pipe lines, a definite set of procedures has been established so that the purchase of new materials may result in orderly field distribution and construction into completed improvements.

Most orders for new materials and machinery originate in the department's engineering division where bills of material and detailed specifications for equipment are prepared. Material requisitions are processed through the company's purchasing department, which actually handles the purchase transaction with the supplier. In cases where critical items of machinery or other material are being purchased, quotations are received from a variety of suppliers in order that the most suitable selection can be made. Purchases are made by agents and each agent buys only a select group of items in which he has been carefully trained. Items purchased for construction are shipped direct to the job site for immediate use and a minimum of material is ordered for replacement warehouse stock as standby material or as consumable supplies. This method eliminates paper work, extra handling, and additional freight charges. Pipe line operators often conduct extensive investigations to determine what particular manufacturers of pumps and machinery best suit their requirements, and after these determinations have been made, warehouse stocks of machinery spare parts for these items often become a controlling factor when ordering similar new machinery for replacement or expansion. Thus, it is extremely important from the standpoint of management to keep spare parts stock at a minimum operating level and thus be in a position to purchase new improved machinery from other firms.

Materials at Job Site

Materials are received at the construction job site by truck or rail freight, whichever transportation provides the most economical means of obtaining material delivery on schedule. Materials are received on the job either by a field engineer or a material and time clerk. As each construction project is planned and developed to the field construction stage, an orderly procedure is followed to determine the maximum quantity of warehouse stock to be used on the project and the arrangement for transfer of this stock is handled as part of the bill of material covering each design drawing. As this bill is an individual sheet independent of the drawing, copies may be distributed to fabricating shops.

After construction has been completed, a job inventory is compiled from the accumulated record of materials built into work. This record is used to determine the total construction price, and also serves to record substitutions of material. A second inventory is taken to record materials surplus from construction, and these materials are either returned to the supplier, sold to other companies, or returned to warehouse stock, depending on future requirements. Receipt of materials into warehouse stock is accomplished on a regular warehouse record form, which is covered in a subsequent section.

Central Warehouse Functions

Stock received at the central warehouse is inspected, and before being entered on the stock list, is cleaned, repaired, and preservative coating applied if necessary, by the warehouseman. Items received into warehouse stock are recorded on a special warehouse form, which indicates the quantity, value, description, and location in the warehouse. Material is occasionally received from construction jobs for warehouse disposition that has been removed from the system, damaged, or is otherwise unsatisfactory for use, and this class of material is recorded as junk and assembled for the next sale of junk material.

Warehouse stock may be received or issued on the same warehouse form. and prior to shipment of any material,

FIG. 1. Map showing Standard Oil Company products pipe lines and location of central warehouse.

FIG. 2. Sample form of warehouse material order.

ORIGINAL TO WAREHOUSE

STANDARD OIL COMPANY
PRODUCTS PIPE LINE DEPARTMENT
WAREHOUSE MATERIAL ORDER

No. 25

DATE APRIL 27, 1949

FROM ROCHELLE CENTRAL WAREHOUSE

TO DUBUQUE PUMP STATION

CREDIT % 1600-4 DEBIT % 179-160-141-59

USE FOR MANIFOLD PIPING
JOB DESCRIPTION OR WHSE. STOCK

APPROVED ☒ REJECTED ☐ COMPLETED ☐

QUANTITY ORDERED	QUANTITY ISSUED	NEW SM	DETAILED DESCRIPTION OF MATERIAL	STOCK NO.	PRICE	
2	2	N	4" GATE VALVE 150# A.S.A. WESTCOTT OSAY RAISED FACE	04-40-042-113	98 00	196 00
2	2	N	4" STANDARD WEIGHT 90° LONG RADIUS WELDING ELBOW	04-32-120-040	5 21	10 42
2	2	N	4" FLANGE WELDING NECK A.S.A. 150# RAISED FACE	05-31-115-042	4 20	8 40
10'	10'	N	4" PIPE 11.35# PER FOOT .250 WALL THICKNESS, SEAMLESS STEEL PLAIN END	12-04-250-111	83	8 30

CANCELLED

ORDERED BY S. E. BROWN, Chief Sta. Engineer TRANSFER NO. 76

APPROVED BY R. H. STARRETT, District Supt. SHIPPED BY J. W. DUSENBURY, Warehouseman

PIPE TALLY

LOCATION Rochelle Central Warehouse DATE July 7, 1949
DIA. SIZE 8" NEW ☒ S.H. ☐ JUNK ☐
WEIGHT PER FT. 24.70 WALL THICKNESS .277
SMLS ☒ LAP WELD ☐ BUTT WELD ☐
PLAIN END ☒ SCREW END ☐
FROM National Tube
CAR INITIAL AND NO. LVL 130061 TRUCK NO. 39416
TALLIED BY John Dlam TRUCK DRIVER Mason

	FEET	10TH	FEET	10TH	FEET	10TH	FEET	10TH	FEET	10TH
1	38	3	39	3						
2	39	2	36	9						
3	38	0	38	7						
4	36	9	39	6						
5	37	4	38	2						
6	40	2	38	5						
7	39	3								
8	38	7								
9	41	5								
10	37	6								
11	38	1								
12	38	2								
13	39	8								
14	37	9								
15	40	5								
16	38	6								
17	39	1								
18	38	7								
19	38	4								
20	38	9								
TOTAL	775	3	231	2						

CANCELLED

TOTAL NO. PCS. 26 LENGTH 1006 FEET 5 10TH
TRANSFER NO. 26459 ORDER NO. GOOL 98217
Form P-73 8-41

FIG. 3. Pipe tally for taking inventory of pipe yard.

it is inspected, crated or packaged for shipment, and weighed to determine shipment rates. Volume shipments of small items such as bolts, bushings, and a variety of such bulk materials may be issued by weight prior to packaging, a process that saves considerable time in eliminating an actual count.

A complete inventory of stock is taken semi-annually and this inventory indicates the location, quantity, description of items, and the total stock value of each item. Considerable savings in time is effected by preparing mimeographed copies of one annual inventory for use in successive years. If stock is maintained at a normal level, such copies are adjusted as to quantity, with additional sheets for items not originally inventoried. This process effects considerable savings in clerical time at the warehouse. Misrepresentation of stock sometimes results in improper or varied description of the same material and this contingency is overcome by a uniform method of describing all normal stock.

Maintenance of stock in usable condition is a continuous problem for the warehouseman, and many items require special precautions. For instance, particular emphasis is placed on storage of materials that can be damaged by water or water vapors. Storage of electric motors and other electric machinery often presents a problem of guarding against vapor corrosion. This factor has been successfully overcome by heated storage

BUILT TO SPECIFICATIONS!
a "packaged unit" case history

This Leland "Packaged Unit" Body was designed and built for one of the country's leading oil companies for use on their development projects located in the rugged terrain of South America.

More and more oil companies and pipe line contractors are selecting the Leland "Packaged Unit" Body for its wide range of trouble-free service, rugged construction, easy on-the-spot installation and design for specified requirements.

Consult a Leland representative today. He'll be glad to show you how a Leland "Packaged Unit" Body can be tailored to your specific requirements.

CHECK THESE FEATURES

LELAND TRUCK BODIES

... are equipped with tail roller fabricated from hydraulic tube, rolling on bearings supported by heavy steel castings; steel fabricated frame; 2 inch, center match hardwood deck; headache rack of heavy duty tubing and gin poles of heavy duty drill pipe.

TULSA WINCHES

... equipped with an irreversible worm and gear which are designed to hold a load while raised. As an added safety factor Tulsa Winches are also equipped with an automatic worm brake which necessitates the load being lowered by power. Few moving parts provide years of dependable, trouble-free service.

SPECIAL! CONTRACTORS:

Send for interesting booklet on the CLEVELAND BABY DIGGER (model 92). Find out how this small, compact, tough trencher can save you both time and money on the job.

PARTS DEPOT * CLEVELAND TRENCHERS

Leland
EQUIPMENT COMPANY
OKLAHOMA CITY • TULSA • LONGVIEW, TEXAS

WEDGE O.D. Caps slip on and off quickly and easily. They will lock securely on a smooth surface WITHOUT WELDING and will come off at the job in LESS TIME. All pipes should be protected in transit to prevent damage to ends and against foreign matter that

might cause severe damage. Your pipe will reach you undamaged and the inside clean eliminating the necessity of swabbing. Specify WEDGE O.D. Caps on your next order and you will get positive protection and will use less time removing caps.

Write for Information

WEDGE PROTECTORS, INC.

3977 Jennnigs Road, Cleveland 9, Ohio

WEDGE
Split CHILL RINGS
SAVE MONEY

STANDARD OIL COMPANY
PRODUCTS PIPE LINE DEPARTMENT

Order No. _____ **MATERIAL TRANSFER** No. 21

Date Material Moved APRIL 28, 1949 — ORIGINAL—SEND TO CHICAGO ACCOUNTING DEPT. — Date Transfer Made APRIL 28, 1949

Shipped By Freight _____ Paid by Check No. _____ $ _____
Shipped By Express _____ Paid by Check No. _____ $ _____
Hauled By Truck ROCHELLE MAINTENANCE CREW

From ROCHELLE CENTRAL STOCK
To DUBUQUE PUMP STATION
AUTHORIZATION 9791

Was This Material Replaced? YES Give Tfr. Nos. GOPL 7777, 7778, 7779
Give Acquisition Reference, Auth. No. 9223 Tfr. Nos. #7 #17 #27

THE COLUMNS BELOW ARE TO BE LEFT BLANK FOR CHICAGO OFFICE USE

CLASS	DETAILED DESCRIPTION OF MATERIAL	QUANTITY Pieces	QUANTITY Ft. or Lbs.	CODE NO.	PRICE Dollars	PRICE Cents	VALUE	DEP'N	SALVAGE PRICE	NET VALUE	ANALYSIS DISTRIBUTION
	4" Gate Valve, 150# ASA	2									9791-57-160-141
	Westcott, OS&Y, R. F.										
	4" Standard Weight L. R.	2									9791-57-160-141
	Elbow Welding 90°										
	4" Flange, Welding	2									9791-57-160-141
	Neck, ASA 150# R. F.										
	4" Pipe 11.35# Per Foot .250 Wall Thickness Seamless Steel P. E.	1	10'0"								9791-57-153-1
	WHEN MATERIAL IS SHIPPED BY FREIGHT OR EXPRESS ATTACH ORIGINAL BILL OF LADING TO THIS COPY					TOTAL					

CANCELLED

Receipt Copy to S. E. BROWN
Address DUBUQUE, IOWA
Correct M. Vance, District Clerk, Storekeeper
Approved R. H. Starrett, District Superintendent

FOR USE OF ACCT'G DEPT.

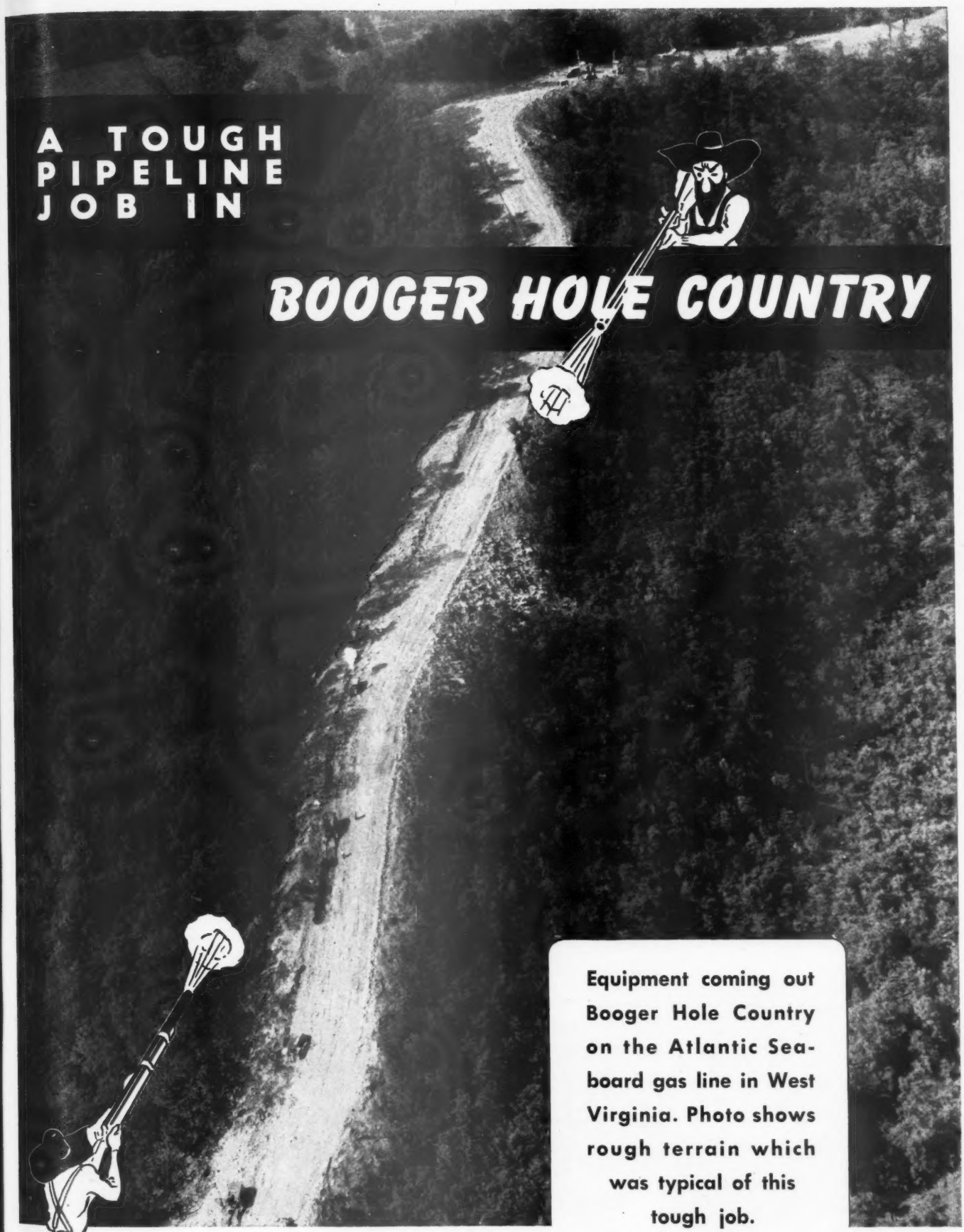
Priced By _____ Extended By _____ Checked By _____
Approved (Material, Accts., and Prices) _____

Form P-81 8-49

FIG. 4. Sample form used to transfer material to other locations.

FIG. 5. Typical warehouse building erected from prefabricated steel panels and trusses.

FIG. 6. Illustration shows prefabricated warehouse building elevated for truck loading and fenced for security.



Equipment coming out Booger Hole Country on the Atlantic Seaboard gas line in West Virginia. Photo shows rough terrain which was typical of this tough job.

Ray L. Smith & Son, Inc.

PIPE LINE CONTRACTORS

HAZLETT BUILDING ★ EL DORADO, KANSAS

space, use of vapor-resistant wraps, seals and coatings, and sometimes by use of sacks or trays of dehydrating agents such as a silica gel and activated alumina. Items protected by dehydrating agents must be available for occasional inspection and regeneration of the drying media. Protection of forgings and castings against rust is solved by conventional methods of cleaning and coating and this work can be accomplished by maintenance crews during winter months, or when line work is impracticable.

The pipe line warehouse usually stores and distributes consumable supplies required for office and field functions, and such supplies are ordered on a scheduled basis and shipped to field locations quarterly, semi-annually, or at other intervals. Such stock is normally kept in an accessible location, and because it is handled in light bulky containers, may be shelved on top of heavier items.

Warehouse layouts are sometimes made for a predetermined volume of stock, and when a reasonable estimate of floor loadings can be made, floor areas are designed and zoned according to the maximum safe loads they will carry.

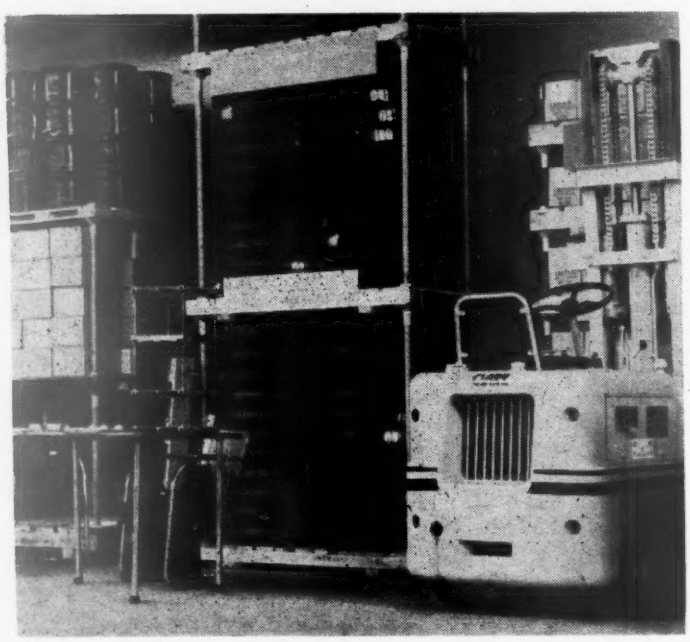
Some companies are equipped to handle small amounts of routine pipe fabrications with their own personnel and fabricating jigs. Facilities for this work are sometimes situated at a warehouse convenient to the storage of pipe and fittings. It has been the experience of Standard, however, that it is poor economy to handle more than a routine amount of such fabrication for other than training and "fill in" work. Projects requiring a significant amount of fabrication can be accomplished at a saving by farming the work out to commercial fabricators who do business on a volume basis.

Many items of normal warehouse stock require special storage precautions. Particular emphasis is placed on the safe storage of packaged lubricants, fuels, thinners, paints, varnishes, and similar flammable items. If such stock is stored in the general warehouse it should be confined to a special room sheathed with fire-resistant material, well vented, and accessible only from outside the building. Storage of the above stock is additionally hazardous when the containers have been opened and partially used, thus leaving a vapor space.

Considerable development and progress during recent years has produced a variety of mechanical equipment for handling heavy items. When the volume of stock movement warrants such consideration, one or more of these machines may be used to advantage in a warehouse layout. In warehouses where some pipe fabrication is done, a monorail hoist can be used in transferring heavy parts to the fabricating shop and loading completed assemblies for shipment. Where it appears advisable to use prefabricated metal buildings, trusses for these structures can be adapted for monorails with minor modifications.

Customary bins and racks for storage of pipe line materials are gradually being replaced by more efficient use of stacking pallets. These flexible units are currently being designed for storage of a wide variety of stock and carrying concentrated loads on a very economical basis. In the past it has been common practice to stack valves and heavy fittings at floor level only to such a height as would permit access and easy removal, where current developments in stacking pallets will permit full use of the clear height of the warehouse building without limiting immediate access to any of the stored items. Warehousemen operating a palletized warehouse and one fork-lift truck can effectively handle receiving, stacking, and issuing of warehouse materials with a minimum of assistance. The elimination of needless handlings and hazards of hand labor improves efficiency of the operation, increases man hour productivity, and lowers unit cost of warehousing of all items. Illustrations are included to show the use of fork-lift trucks and stacking pallets in storing consumable supplies, packaged paints and lubricants, tires, small forgings, and such irregular nonstacking materials as sacks of graphite, sheets of packing, etc. By efficient use of stacking pallets and consequent reduction in warehouse area, the total cost of a warehouse installation is approximately half the cost of a structure where materials are stored on skids, one tier in height. The investment in a fork-lift truck may readily be paid out only by replacing the

FIG. 7. Illustration of use of stacking pallets and forged steel separators storing a variety of warehouse stock.



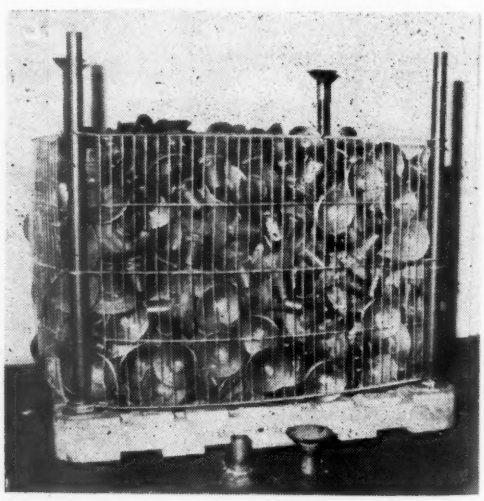


FIG. 8. Method of storing small forgings and miscellaneous parts on stacking pallets.

WALWORTH

manufactures both Gate Valves and Lubricated Plug Valves for pipe line service

The Walworth 26-inch Series 600 Cast Steel Gate Valve shown here is for pipe line service. It is a motor operated, double disc, parallel seat type of gate valve with hard faced seats and discs; flanges faced and drilled. The valve is designed for 1200 psi working pressure — and meets all the requirements of API Standard 6-D for Pipe Line Valves.

In addition to motor operated valves, pipe line gate valves are available for handwheel operation, either direct or through single or double enclosed beveled gears.

Walworth Pipe Line Gate Valves are handling crude oil, fuel oil, gasoline, and other petroleum products in many of the most important pipe lines of the world.

In addition to double disc cast steel pipe line gate valves, another popular valve for pipe line service is the Walworth Lubricated Plug Valve.

Illustrated is a Walworth 26 by 24-inch Lubricated Plug Valve for 960 pounds working pressure, with a high pressure cylinder for use in conjunction with automatic valve control. Manufactured for service on a natural gas pipe line.

- Made of cast steel and conforms to API Standard 6-D for Pipe Line Valves.
- Roller bearings permit easier opening under pressure.
- Tight sealing — resistant to wear and corrosion — dead tight shut-off — pressure sealed.

For further information regarding either Gate Valves or Lubricated Plug Valves for Pipe Line service, see your nearby Walworth distributor, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

WALWORTH

valves and fittings

60 EAST 42nd STREET NEW YORK 17, N.Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

FIG. 9. Orderly warehouse arrangement zoned for location and floor loading. Shows storage of consumable supplies and spare parts.

FIG. 10. Use of stacking pallets applied to various nonstacking materials.

work of one man for one year, and the advantages of such equipment are too numerous and too well known to be treated here.

One of the key functions to efficient warehouse operation is the disposal of surplus stocks, obsolete material, and junk. In large companies disposal of surplus stock is normally accomplished by circulating inventories of such material throughout all branches and subsidiaries of the company before offering the items to public auction, where less revenue is obtained. Obsolete material and junk can usually be disposed of only through local dealers and accordingly it is desirable that a warehouseman keep apprised of the prices of scrap steel, brass, lead, etc., to take maximum advantage of sales of junk materials. He should also check price fluctuations on "fringe" stock that is not definitely required for immediate use and can be sold at a price advantage.

Central Control System

As the work of design engineers in their planning of new and revised pipe line facilities is closely associated with and influenced by items carried in warehouse stock, it is necessary that a central stock control system be operated at the pipe line office. Such a stock control system kept reasonably current is used as a guide in preparing bills of material for proposed work and items are ordered out of warehouse stock whenever possible to eliminate purchase of duplicate new material. If this procedure is not followed there is no adequate method of keeping usable warehouse stock at a practical level. A sample of a card file index system operated by Standard is shown in Fig. 11, and illustrates the method of recording a specific item on individual cards. The resultant perpetual inventory permits immediate reference to field stocks and may be kept posted to date with a minimum of effort. Transfers of material in the field are recorded from information copies of the warehouse papers. Although this type of system may not be the best answer to central stock control, it has performed satisfactorily to date.

From the foregoing it may be seen that your warehousemen are an active integral part of the pipe line business and, although their work is not of a spectacular nature, efficient warehousing has a definite place in the economics of a successful pipe line. Considerable money can be saved or lost, depending on management's foresight in understanding and helping to solve basic warehousing problems. * * *

DATE	REQ. NO.	ON ORDER	TRANSFERRED IN	TRANSFERRED OUT	BAL.	DATE	REQ. NO.	ON ORDER	TRANSFERRED IN	TRANSFERRED OUT	BAL.
7/31	INV.				43	12/6	GOPL 99215		20		23
8/2	439			5	38	1/4	593			9	14
8/11	450			2	36	1/9	MT 498		3		17
8/23	462			7	29	1/30	625			1	16
8/26	MT 375		4		33	2/15	633			4	12
9/5	478			12	21	2/18	MT 514		18		30
9/7	483			3	18	3/27	642			8	22
9/12	MT 401		1		19						
9/21	499			11	8						
9/21	GOPL 98111	20			8						
9/29	507			4	4						
10/13	523			1	3						
10/19	GOPL 98111		20								
10/27	541			8	15						
11/3	MT 483		2		17						
11/14	563			6	11						
11/16	567			5	6						
11/16	GOPL 99215	20			6						
11/25	578			3	3						

CANCELLED

SPECIFICATION: 8" STANDARD WEIGHT WELDING ELL, 45°, L. R.

04-32-220-080 | LOCATION: ROCHELLE | MANUFACTURER | MANUFACTURER'S NO.

FIG. 11. Illustration of stock card for general office central warehouse control system.

Recirculating Cooling System Waters

General information report on the factors that must be considered for satisfactory operations

E. G. HAMMERSCHMIDT

The conditioning and handling of cooling water has been a problem of major importance in station operations since Texoma Natural Gas Company's pipe line was first placed in operation in August, 1931. The history of this problem since the beginning of operations shows a gradual but continuous improvement up to the present time. Many problems have been solved; some of them have been of major importance although they were not always recognized as such in the beginning. The problem is complicated by the fact that water conditioning requires the consideration of three interrelated factors: (1) Scale formation, (2) corrosion, and (3) microbiological growths. Both scale and microbiological growth may be factors in the corrosion of metallic equipment although a thin layer of unbroken scale is usually a fair protection against corrosion. Microbiological growths (algae and bacterial slimes) may impede the flow of water through the system, and when baked on heat transfer surfaces they act as an insulator against heat transfer in the same manner as a heavy scale deposit. On the other hand, there is evidence that these microbiological growths have some scale inhibiting power, apparently acting in the nature of a colloid and tending to hold the scale in suspension and thereby preventing its baking on heat transfer surfaces. This action is not yet fully understood and there are doubtless other problems that will arise in the future.

The complexity of this three-fold problem may be more readily comprehended if it is realized that the following factors have some effect on the overall picture: Temperature encountered in the system, velocity of flow, pH of make-up and circulating waters, calcium and magnesium concentration, dissolved solids concentration, silica concentration, dissolved gases such as air, carbon dioxide, and hydrogen sulfide, total alkalinity, types of algae and bacteria, climatic conditions and water conditions favoring algae growth, relative chloride or sulfate content of system water, contamination with atmospheric dust, contamination with oil, proper treatment of make-up water, variations in composition of raw water supply, and materials of construction.

It is the purpose of this article to review the history of water conditioning of station cooling waters as pertains to Texoma operations and to state our best opinion, at the present time, of what it takes to operate our water cooling systems properly.

What System Water is Required to Do: An internal-combustion engine will consume roughly 10,000 Btu per bhp-hr of which 2545 Btu is converted into useful work. Of the remaining 7455 Btu, approximately 40 per cent, or 2982 Btu, is rejected to the exhaust, leaving 4473 Btu per bhp-hr to be dissipated by the cooling water. The heat absorbed by the cooling water is then removed in the cooling tower by a heat transfer process that involves: (1) A latent heat transfer due to the evaporation of a small portion of the water, and (2) a sensible heat transfer due to the difference in temperature of water and air (convection and radiation). The sensible heat transfer is small in comparison with the latent heat transfer. For example, the experimental cooling system that is now being used in the laboratory to study scale and corrosion problems, shows that about 70 per cent of the heat is dissipated by evaporation and the remaining 30 per cent is presumably removed by sensible heat transfer. For estimating purposes, the latent heat of water is usually assumed to be 1000 Btu per pound of water evaporated. Neglecting, for the moment, the amount of sensible heat transfer, the amount of evaporation required to remove the heat from one 1250-hp engine per day would be as follows:

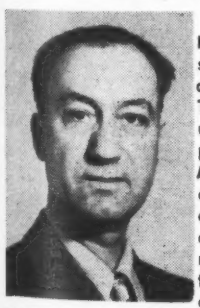
$$\frac{4472 \times 1250 \times 24}{1000 \times 8.34} = 16{,}000 \text{ gal}$$

per day per engine.

Inasmuch as about 30 per cent of the heat load is dissipated by sensible heat transfer, the net daily evaporation requirement for each 1250-hp engine would be: $16{,}000 \times 0.70 = 11{,}200$ gal. The evaporated water leaves all the solids, both dissolved and suspended, within the system and continued addition of make-up water results in greater and greater solids concentration until a point is reached when it becomes necessary to blow down a portion of the system water in order to maintain satisfactory operating conditions. Total make-up requirements are the sum of evaporation losses plus blow down losses.

Piston Water Service (PWS) Corrosion: In the early days of operation, serious corrosion was experienced in the PWS tubes. Deep channels were cut in the bore of the tubes and deep pitting and sometimes penetration occurred in the dams within the tubes. During this period, "water hammer" was of frequent occurrence. In 1939, indicator cards were taken on the PWS air chambers and they showed very great pressures on the "hammer" end of the stroke while the other end

The Author



Elmer G. Hammerschmidt, chief chemist for the Texoma Natural Gas Company, a native Missourian, received a B.S. degree in chemical engineering from the University of Iowa in 1922. He was assistant superintendent of natural gasoline plants at Caney and Madison, Kansas, for Cities Service Company from 1922 to 1926, and then became research chemist for the Empire Oil and Refining Company until 1931. In that year he was made chief chemist for the Texoma Natural Gas Company, the position he now holds. His headquarters are at Fritch, Texas. He is a member of the American Chemical Society, American Institute of Chemical Engineers, American Water Works Association, and the American Gas Association, and in 1939 received the Beal Medal Award bestowed by AGA.

EXCLUSIVE

of the stroke frequently showed a partial vacuum. System water is completely saturated with air when it passes downward through the cooling tower, and it was surmised that some of this dissolved air might be liberated as a gas during the vacuum part of the stroke and thus enhance corrosive conditions within the PWS tubes. A spiral screw was placed in the hollow piston rods in order to force the water through the tube in a tangential rather than a stream line flow. This improved the water hammer but it resulted in excessive wear on the outside of the rod. In the old style rods the water enters the rod bore on the inboard side, leaves the inboard rod near the dam at right angles, and enters the lower side of the hollow piston. It leaves the top side of the piston and enters the outboard piston rod in the same manner. In the newer rods, the water leaves (or enters) the rod and piston at a 45-deg angle in order to more nearly approach a streamline flow and thus minimize cavitation erosion at the dams.

The problem was eventually solved by installing small air compressors that would maintain about 20 psi at the discharge, and bleeding this air through a ¼-in. needle valve (¼ to ½ turn open) into the PWS air chamber. This feature not only stopped the water hammer but it decreased the corrosion as well. For example, a steel test piece placed for 62 days in a PWS elbow at Station 21 before air injection was started, corroded at the rate of 27 mils penetration per year, whereas a similar test that was made after air injection was started, decreased to 4 mils penetration per year.

Corrosion Prevention by Deaeration or "Gasification": The original supply of deep well water at Station 10 was quite corrosive. The PWS was especially affected by deep cavitation, pitting, and general etching of the metal. The addition of a chromate type inhibitor was not satisfactory because, as is often the case with inhibitors, the total amount of corrosion was reduced but the remaining corrosion was concentrated upon a limited metal area and the overall damage was actually increased because of this localization. The results of a series of laboratory experiments indicated that deaeration of system water would inhibit corrosion and it was further demonstrated that the water could be deaerated by bubbling oxygen-free natural gas through it. A pilot plant, constructed at Station 10, confirmed that corrosion could be prevented by contacting the system water to the engine jackets with the fuel gas prior to its entry to the engine fuel header.

A plant size deaerating or "gasification" column was placed in operation at Station 10 in November, 1939, and after final adjustments were made, practically all corrosion was stopped in the area served by the "gasified" water. It was also found that air injection into the PWS air chamber was not required after the water was "gasified." Apparently enough free gas remains in the deaerated water to prevent "water hammer." These deaeration towers have been recently installed at all main line stations.

Control of Jacket Water Temperature and Velocity of Flow Through Jackets: In the earlier days of operation, cold system water was pumped directly from the basin of the cooling tower through the engine jackets, where the water flow was reduced in order to hold the outlet water temperature at 140 F. With comparatively cold inlet water entering the lower side of the water jacket and 140 F water leaving at the top of the jacket, this temperature differential has a tendency to bow the cylinder barrel since the top becomes longer because it is hotter. Large temperature differentials therefore may set up undue heat stresses, excessive piston wear, and possibly piston seizure. In some research work at Purdue University in 1940, it was shown that scale deposi-

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tion on heat transfer surfaces could be reduced by increasing the velocity of flow of water across such surfaces. We have found this to be true also in compressor operation and the water is now pumped through each jacket at the full capacity of the equipment. The resulting increase in velocity through the water jackets tends to prevent sedimentation of suspended matter within the jacket and also to give better heat transfer to the water at the hot cylinder wall.

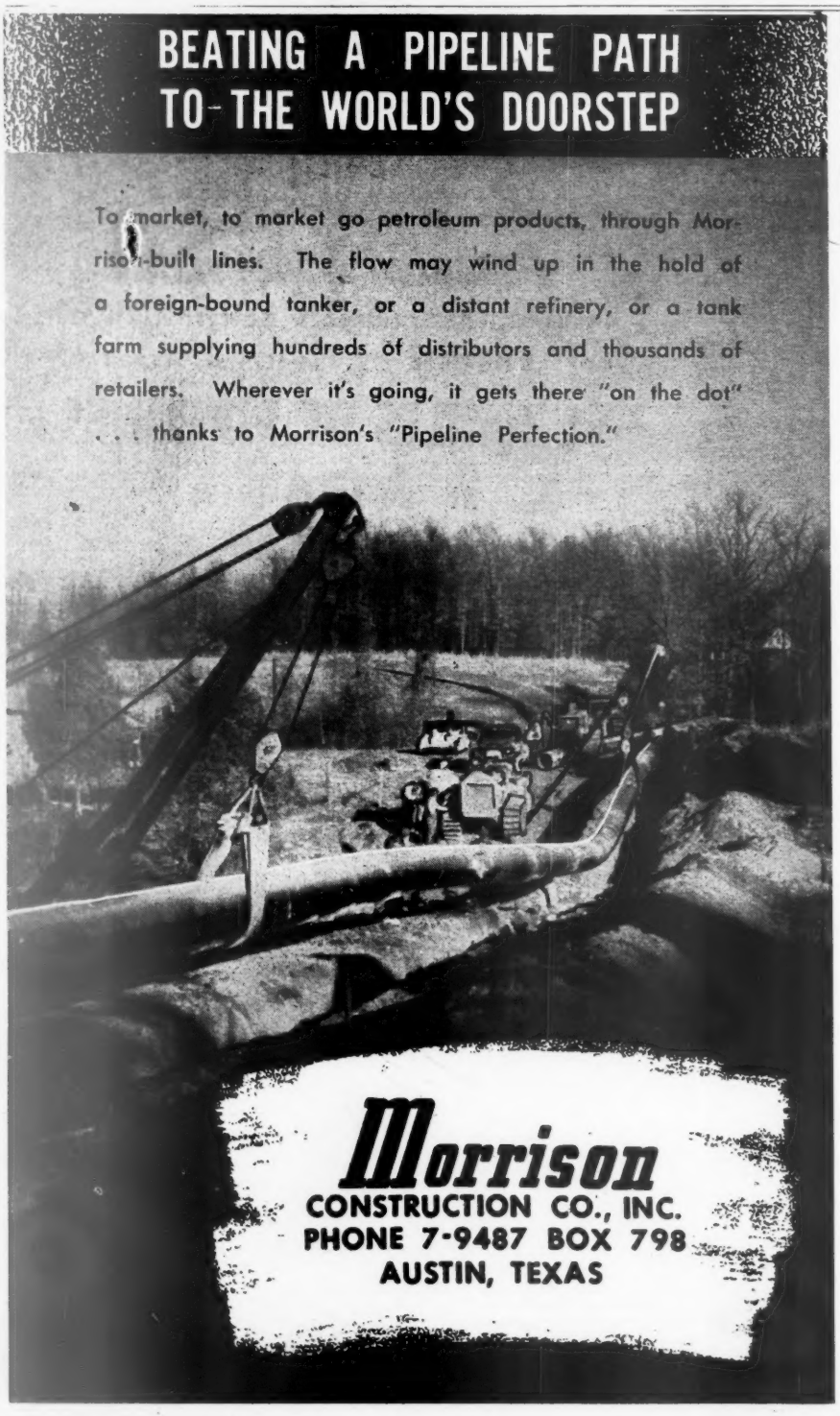
The temperature differential between jacket inlet and outlet water has also been brought under control by the installation of crossovers or by-pass lines and control valves between the suction lines to the hot well pump and the cold water pump. This permits the entry of water of any desired temperature at the jacket inlet. Normally this temperature, for main engines, is maintained near 100 F and the jacket outlet temperature is usually about 20 F higher, or 120 F. Auxiliary engines are usually operated at inlet water temperatures of 120 F to 125 F in order to prevent condensation in the crankcase with subsequent sludge formation in the bottom of the crankcase.

Microbiological Growths: Microbiological growths consist of: (1) Algae, which are simple plants that require sunlight and air, (2) sulfate reducing bacteria, which produce hydrogen sulfide in their metabolism and may result in corrosion of iron and copper containing metals, (3) Crenothrix or iron consuming bacteria, which may aid in the corrosive process, and (4) the capsulated or slime forming bacteria, which do not require sunlight in their growth. The multiplication of all these organisms is enormous and they may cause operating trouble by clogging cooling tower decks, suction screens and pumps, and by settling and baking on heat transfer surfaces. The only known cheap chemical compound that will kill all these microbiological growths is chlorine. Chlorine, however, will also react with oil and other organic matter that might be in the water, it is quite volatile and may be partially lost by aeration in the cooling towers, and when present in large enough quantities it is very corrosive to metallic equipment. It must also be applied more or less continuously. These features may increase the costs of application to an undesirable point. The main line stations are equipped to use chlorination but at the present time it is not being used.

An experimental setup at Station 6 is indicating that the algae can be controlled by closing in the cooling towers in such a manner that sunlight cannot reach the parts where algae growth is normally most prolific. Present indications are that the remaining bacteria can be tolerated without too great difficulty in operations.

Oil in System Water: There have been some reports in the literature that emulsified oil has sometimes been added to water as a corrosion preventive. Other authorities have reported that oil may accelerate corrosion of the pitting type. Analyses of sludge that has settled out of our system waters have always shown a high concentration of oil. This is good evidence that the oil acts as a trap or binder to accumulate other suspended matter such as silica and calcium, until the particle becomes heavy enough to sink or perhaps settle on heat transfer surfaces where it may bake and form an insulating layer. This leads to the conclusion that oil contamination in system water, as in boiler water, should be prevented if at all possible.

Softening—Scale and Sludge Control: The raw water supply at all stations comes from wells that produce hard water. If the raw water were pumped directly into the cooling system recirculated water, engine jackets and cooling coils would soon become heavily coated with scale and plant operations would soon become unten-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able. In order to alleviate this situation, all stations have been provided with water softeners. Zeolite softeners are located at Stations 1 to 7 and Station 10. Stations 22 and 9 have a Spaulding lime precipitator followed by a zeolite softener. Station 8 has an International lime treater with a filter and zeolite softener for retreating a portion of the system water. Station 21 uses two zeolite softeners. One is regenerated with salt brine in the conventional manner but the other softener, which contains carbonaceous zeolite, is regenerated with sulfuric acid. The lime softeners reduce the alkalinity of the treated water but they will not reduce the total hardness as much as a zeolite softener. A conventional zeolite softener, using salt brine for regeneration does not affect the alkalinity appreciably. An acid regenerated softener, on the other hand, will reduce the alkalinity; in fact, it produces acidic water, and at the same time it will reduce the hardness as low as the conventional brine softener. The acidic water is neutralized with the alkaline effluent from the brine regenerated softener to produce a blend of any desired alkalinity. It must be remembered that softened waters contain some residual hardness and there is a limit to the amount of evaporation that can be permitted without obtaining some scale deposition. Softeners should be operated so as to obtain the greatest possible reduction in hardness of the inlet water. The minimum effluent hardness of a zeolite softener varies with the compensated hardness of the inlet water, ranging from 2 to 10 ppm with raw waters having 100 to 500 ppm compensated hardness, and up to 30 ppm with raw water of 700 ppm compensated hardness. In order to determine whether the softeners are operating properly at all times, a continuous sample of softener effluent is collected for weekly analyses of the composite sample.

The amount of scale-forming constituents that can be held in solution in system water depends not only on the amount of such constituents in the system water, but also on the pH, alkalinity, temperature, and, to a lesser extent, the total dissolved solids in the water. The effect that each of the above factors has upon the scaling tendency has been expressed mathematically by Langelier. Langelier's equation was later modified by Ryznar so that it would more closely approach operating conditions in recycle water such as our system waters. Ryznar's method is the best guide that has been found to date for controlling the required blowdown of our system waters in order to prevent scaling and, to some extent, to decrease corrosion. It shows the temperature range within which the water is neither scale forming or scale dissolving. At temperatures above this range, the water will lay down a scale and at temperatures below this range, it will dissolve scale and thus enhance corrosive conditions. A scalar diagram, which is convenient for solving the Ryznar formula, is given in the appendix. This method is practical when used with the proper understanding but it is not precise because it does not take into consideration such factors as the effect of microbiological growths or of other organic matter such as the "tannin like" material that is leached from new redwood towers. These organic materials tend to prevent scale deposition and consequently higher concentrations may sometimes be maintained than is indicated by the Ryznar index. The amount of such increase in concentration is best determined by actual inspection of engine jackets. Substantial increases in concentration have been permissible at Station 22, probably due to the leaching of "tannin like" material from the new redwood towers.

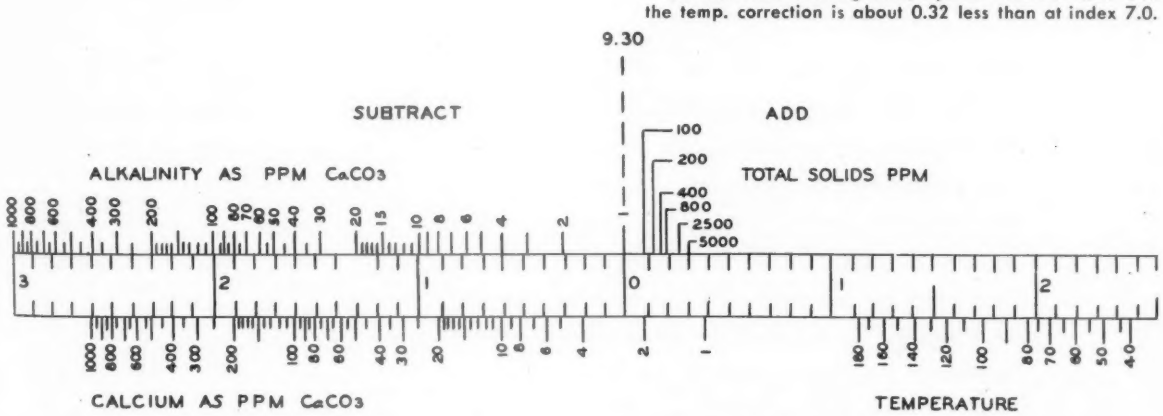
Despite the increased flow of water through the engine jackets, it is not great enough to prevent the settling

Diagram for pH of Calcium Carbonate Saturation
Langelier Formula; Larson-Buswell Total
Solids-Temperature Adjustments
(Adaptation from A. A. Hirsch diagram in J.A.W.W.A. May 1943)

To determine temp. at which water is balanced @ 7.0 Ryznar index:

1. Add 7.0 to pH_1
2. Divide by 2
3. Add Ca and Alky. corr'ns.
4. Deduct 9.3 + Tot. Solia correction.
5. Remainder is temp. corr'n. Find corresponding temp. on Scalar diagram.

On the scale forming side, Ryznar index is 6.35 and the temp. correction is about 0.32 less than at index 7.0.



Directions: To 9.30 add the sum of the scale values opposite the total solids and the temperature figures. From this subtract the sum of the scale values corresponding to the Calcium and the alkalinity.

Example: Given Hardness 26 ppm as $CaCO_3$, Temperature 100 F, Alkalinity 800.
Total Solids 800 ppm; find the pH at saturation.

Solution: $pH_s = 9.30 + (0.18 + 1.74) - (1.0 + 2.92) = 7.30$.

Significance: If actual pH is less than pH_s, the water is undersaturated; corrosive tendency.
If actual pH is greater than pH_s, the water is supersaturated; scale forming tendency.
If actual pH is equal to pH_s, the water is in chemical balance.

Ryznar Stability Index $= 2pH_s - pH_a$.

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of some of the suspended matter upon the jacket walls. If the system water is maintained in chemical balance according to the Ryznar index, however, this deposit will be a loose sludge that can be removed periodically by washing out with a hose during a shutdown period. The amount of such sludge may be reduced by using the cooling tower basin as a settling basin. If a sample of system water is allowed to stand in a jar for a few days, nearly all the suspended matter will settle to the bottom of the jar. At any place in the system where the water remains in a nearly quiescent state for a short time, it may be expected that some sedimentation will occur. Most of the stations have installed a baffle 3 ft high across the bottom of the cooling tower basin where the water flows to the pump suction, for the purpose of trapping some of the heavier suspended or settled solids in the basin and thereby preventing its entry into the engine jackets.

APPENDIX

Typical reactions of water treatment: Note: Compounds underlined are precipitates or insoluble.

Lime:

$Ca(OH)_2$ (lime) + $Ca(HCO_3)_2$ (calcium bicarbonate) = $\underline{2CaCO_3}$ (calcium carbonate) + H_2O (water).

$2Ca(OH)_2$ (lime) + $Mg(HCO_3)_2$ (magnesium bicarbonate) = $\underline{Mg(OH)_2}$ (magnesium hydroxide) + $\underline{2CaCO_3}$ (calcium carbonate) + $2H_2O$ (water).

$Ca(OH)_2$ (lime) + $MgSO_4$ (magnesium sulfate) = $\underline{Mg(OH)_2}$ (magnesium hydroxide) + $\underline{CaSO_4}$ (calcium sulfate).

$Ca(OH)_2$ (lime) + CO_2 (carbon dioxide) = $\underline{CaCO_3}$ (calcium carbonate) + H_2O (water).

$Ca(OH)_2$ (lime) + $MgCO_3$ (magnesium carbonate) = $\underline{Mg(OH)_2}$ (magnesium hydroxide) + $\underline{CaCO_3}$ (calcium carbonate).

$Ca(OH)_2$ (lime) + Na_2CO_3 (soda) = $\underline{CaCO_3}$ (calcium carbonate) + 2NaOH (caustic soda).

$Ca(OH)_2$ (lime) + $2NaHCO_3$ (sodium bicarbonate) = $\underline{CaCO_3}$ (calcium carbonate) + $\underline{Na_2CO_3}$ (sodium carbonate) + H_2O (water).

Alum:

$Al_2(SO_4)_3$ (alum) + $3Ca(OH)_2$ (lime) = $2Al(OH)_3$ (aluminum hydroxide) + $3CaSO_4$ (calcium sulfate).

$Al_2(SO_4)_3$ (alum) + $3Na_2CO_3$ (soda) + H_2O (water) = $2Al(OH)_3$ (aluminum hydroxide) + $3Na_2SO_4$ (sodium sulfate) + $3CO_2$ (carbon dioxide).

$Al_2(SO_4)_3$ (alum) + 3Ca

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$(HCO_3)_2$ (calcium bicarbonate) = $2Al(OH)_3$ (aluminum hydroxide) + $3CaSO_4$ (calcium sulfate) + $6CO_2$ (carbon dioxide).

Sodium aluminate:

$Na_2Al_2O_4$ (sodium aluminate) + $Ca(HCO_3)_2$ (calcium bicarbonate) + $2H_2O$ (water) = $2Al(OH)_3$ (aluminum hydroxide) + $CaCO_3$ (calcium carbonate) + Na_2CO_3 (sodium carbonate).

Zeolite—sodium cycle:

(a) Softening cycle:

$Ca(HCO_3)_2$ (calcium bicarbonate) + Na_2Z (sodium zeolite) = CaZ (calcium zeolite) + $2NaHCO_3$ (sodium bicarbonate).

$CaSO_4$ (calcium sulfate) + Na_2Z (sodium zeolite) = CaZ (calcium zeolite) + Va_2SO_4 (sodium sulfate).

(b) Regeneration cycle:

CaZ (calcium zeolite) + 2NaCl (sodium chloride) = Na_2Z (sodium zeolite) + $CaCl_2$ (calcium chloride).

Zeolite—hydrogen cycle:

(a) Softening cycle:

$Ca(HCO_3)_2$ (calcium bicarbonate) + H_2Z (hydrogen zeolite) = CaZ (calcium zeolite) + $2H_2CO_3$ (carbonic acid).

$CaSO_4$ (calcium sulfate) + H_2Z (hydrogen zeolite) = CaZ (calcium zeolite) + H_2SO_4 (sulfuric acid).

2NaCl (sodium chloride) + H_2Z (hydrogen zeolite) = Na_2Z (sodium zeolite) + 2HCl (hydrochloric acid).

(b) Regeneration cycle:

CaZ (calcium zeolite) + H_2SO_4 (sulfuric acid) = H_2Z (hydrogen zeolite) + $CaSO_4$ (calcium sulfate).

Increase in pH of Zeolite Treated System Waters: As shown in the table of typical reactions of zeolite treated waters in the sodium cycle, it may be observed that calcium and magnesium bicarbonates are converted to sodium bicarbonate. When a water containing sodium bicarbonate is pumped into a boiler, the sodium bicarbonate breaks down to sodium carbonate, and due to the high boiler temperature, some of the sodium carbonate will break down further to give sodium hydroxide. A somewhat similar reaction occurs in system cooling water except on a greatly reduced scale and the conditions are such that free sodium hydroxide is never found in system water. If sodium hydroxide forms at all, it is immediately converted to sodium carbonate on contact with the carbon dioxide in the air from the cooling tower contact. The decomposition from bicarbonate to carbonate in system water is so gradual that no large change in pH occurs at any one pass through the system. It requires prolonged heating at the normal boiling point of water in order to completely convert sodium bicarbonate to sodium carbonate. The temperature of the engine jacket walls is great enough to cause complete conversion to sodium carbonate, and the reason only a small fraction is actually converted is probably due to the short contact time of the water against the hot jacket walls. The conversion that does occur, however, causes an increase in pH of the water and this decreases the amount of scale-forming constituents that can be held in solution. The magnitude of the pH effect can be determined by a study of the scalar diagram. The following laboratory tests show the results of heating sodium zeolite treated water:

	pH	Total alkalinity, ppm	Carbonate alkalinity, ppm	Per cent conversion to carbonate
Aerated sodium zeolite treated water	6.8	196	8	4
Same, heated just to boiling	7.5	196	26	13
Same, heated ½ hr under reflux condenser	8.0	196	36	18
Same, heated 1 hr under reflux condenser	8.0	196	96	49
Same, heated 2 hr under reflux condenser	8.5	196	134	67
Same, heated 5 hr under reflux condenser	8.7	196	196	100

Typical analysis of system water "sludge":

	Weight, per cent
Organic matter	5.22
Oil	47.30
Silica	27.45
Iron and alumina	4.28
Calcium carbonate	10.60
Magnesium carbonate	2.11
Sodium chloride	0.30
Hydrogen sulfide	0.16
Unaccounted for	2.58
Total	100.00

Effect of hard water scale on heat transfer:

The following data, which show the per cent heat loss with varying thicknesses of several kinds of scale, are from a report by the University of Illinois:

Thickness of scale, in.	Soft carbonate scale	Hard carbonate scale	Hard sulfate scale
1/50	3 5	5.2	3.0
1/32	7.0	8 3	6.0
1/25	8 0	9 1	9.0
1/20	10 0	11 2	11 0
1/16	12.5	12 6	12 6
1/11	15.0	14 3	14 3
1/9	....	16 0	16.0

*Operating capacities of phenolic resin cation exchangers with increasing salt consumption:**

Pounds NaCl/Kgr	Salt used, per cent of chemical theory	Pounds NaCl/cu ft	Kgr/cu ft
0.45	270	6 5	14.5
0.55	330	8.8	16
0 63	378	10.7	17
0 70	420	12 6	18
0 76	457	14 43	19
0.81	487	16.20	20

*Laboratory test data, 10-26-46 weekly report.

Simplified formula for estimating lime requirements for water softening:

(Alkalinity as ppm $CaCO_3$ × 0.44 + ppm free CO_2) × 0.0106 = pounds lime per 1000 gal, assuming that lime is 100 per cent CaO.

Commercial lime will have to be corrected for the per cent purity, i.e., per cent CaO.

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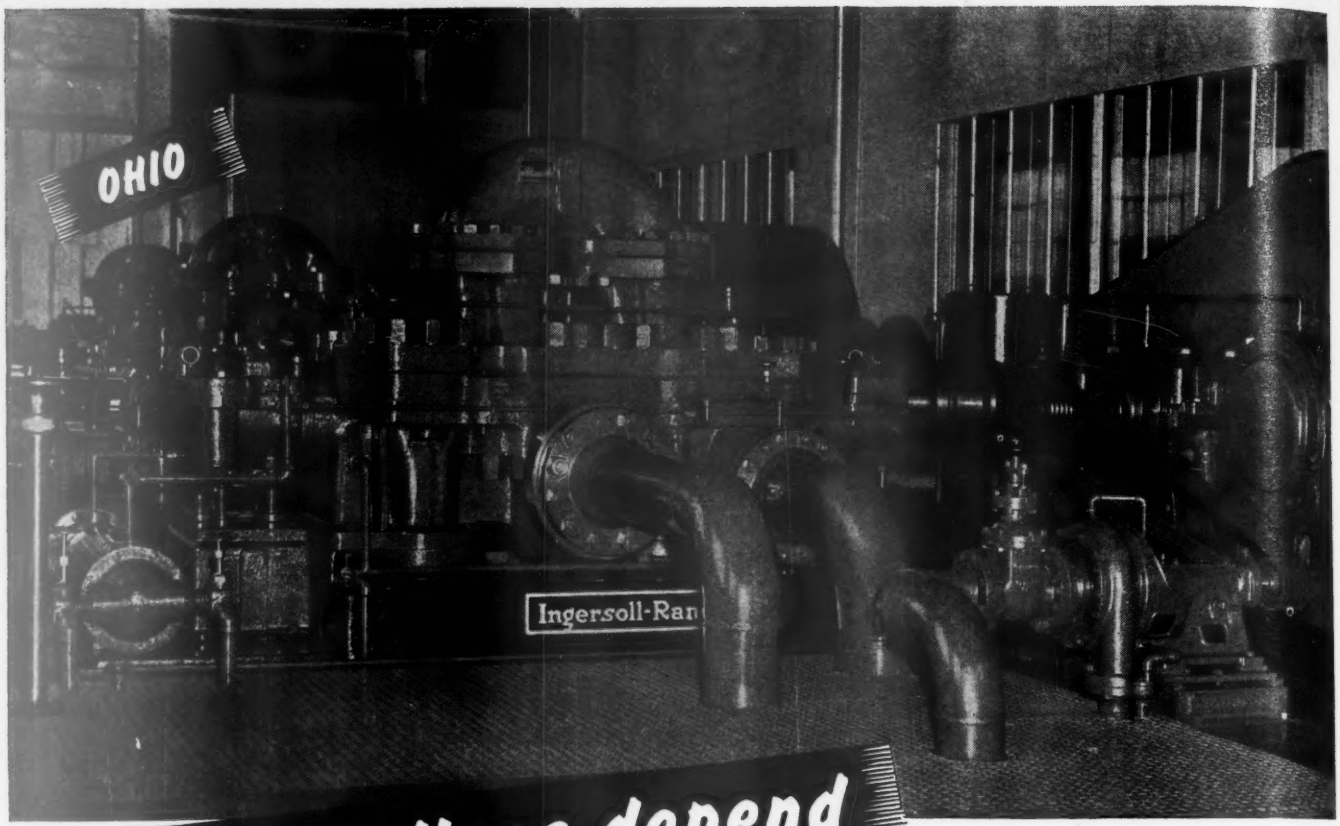

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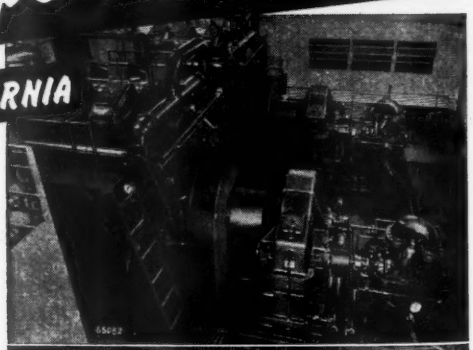

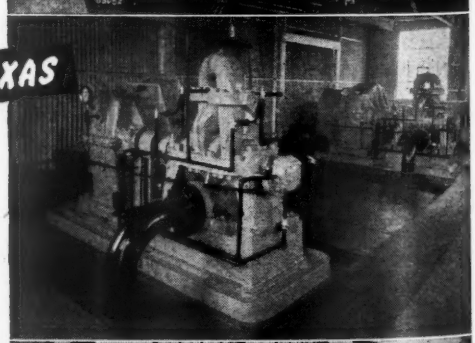

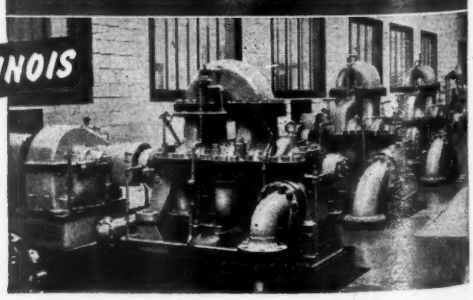

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Lightning Arresters for the Protection of Insulated Joints in Buried Pipe Lines

STANLEY KLEINHEKSEL

DURING the last few years there has been a decided trend, among operators of products pipe lines and crude and gas transmission lines, toward the use of external coatings having increasingly high electrical resistance. These superior coatings are not only being applied to new pipe lines and extensions to existing plants, but also to a substantial mileage of older pipe lines requiring reconditioning. The cost of such coatings is justified amply by the low cost of protecting well-coated lines cathodically, by the relatively small cathodic interference induced in other underground metal structures thus permitting adequate protection, and, by the promise of indefinitely long leak-free life for the pipe line.

Suitably located insulating joints have become increasingly important to the successful application of cathodic protection to pipe lines having high-resistance coatings. Isolation of the coated pipe by this means from pumping stations, terminal facilities, and other relatively low resistance structures permits the achievement of equivalent protection, cathodically, with only a fraction of the current and equipment otherwise required. Of greater importance are the savings realized by a corresponding decrease in cathodic interference with other structures.

Failure of phenolic insulating joint materials because of lightning, or more probably because of power follow current in the pipe line, has proved to be a serious maintenance problem. Burning of the phenolic gaskets, sleeves, or washers may take place; however, our experience indicates that arcing usually occurs between the internal edges of the steel flange faces. A majority of such failures are found in the lower half of the pipe, suggesting that dislodged mill scale, bridging the phenolic gap, may be responsible for determining the course of the arc. Such failures are characterized by a burning of the insulating gasket material to form a rounded slot about ¼ in. deep; the slot being filled with ash and a solidified puddle of metal welded to each flange face, thus effecting a permanent short circuiting of the insulating joint. Besides occurring less frequently, arcing between a flange and a steel washer, nut, or stud, is less likely to cause a permanent short circuit. Typical results of arcing, initiated by lightning, are shown in Figs. 1 and 2.

The Author

Stanley Kleinheksel is in charge of corrosion activities of Socony-Vacuum Oil Company, Inc., Eastern Pipe Line Division, Plainfield, New Jersey. He attended Hope College, Holland, Michigan, the University of Illinois, and the University of Michigan. From the last he received the degree of Ph.D. in electrochemistry in 1935. He was transferred recently from the Socony-Vacuum Laboratories where he wes engaged in refinery corrosion and metallurgy, and since 1941 in pipe line corrosion. He is a member of NACE and ACS.

The mechanism by which lightning, or power follow current from electric transmission lines resulting from a flashover caused by a lightning stroke to a tower or conductor, enters a well-coated buried pipe line and causes the observed damage to insulated joints, is not immediately clear. Lightning damage has been most severe on our 8-in. products line connecting Malvern, Pennsylvania and Binghamton, New York, which, with spur lines, totals 182 miles. This line was completed during late 1948 and in a single season, 1949, 54 per cent of the insulated joints in the line have been short-circuited. Extruded asphaltmastic coating ½ in. thick offers an effective resistance averaging 1,400,000 ohms per sq ft, equivalent to 98 ohms/mile of pipe. Twenty-eight insulating joints serve to break up the line electrically into sections averaging 8 miles in length. There is no metallic connection to pumping stations, terminal facilities, junction manifolds, or other surface or underground metal structures. Valves are in concrete pits equipped with steel covers and no evidence of a lightning stroke to bodies or stems has been noted.

Lewis and Foust's[1] measurements show that lightning stroke currents may reach 160,000 amp; however, their data indicate that whereas 50 per cent of the stroke currents exceed 13,000 amp, only 10 per cent are in excess of 55,000 amp. Moreover, these

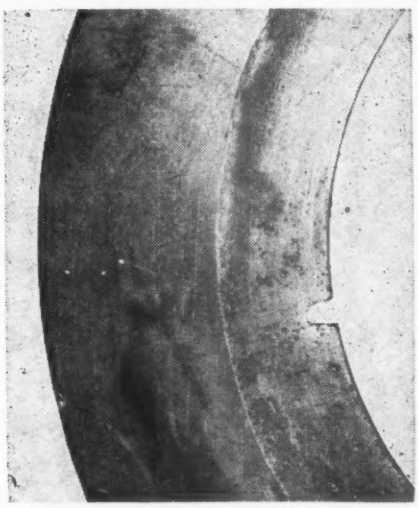

FIG. 1. Section of a 10-in. phenolic flange gasket ⅛ in. thick showing burning at point where arcing caused short-circuiting of insulated joint.

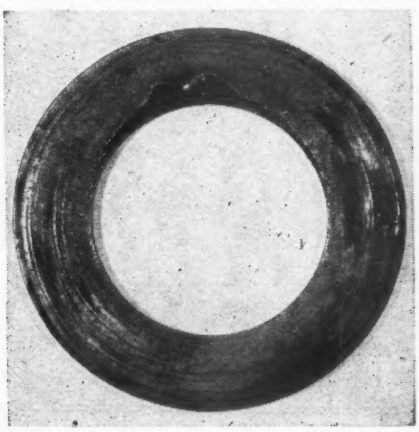

FIG. 2. Shows burning of steel washer of insulated joint assembly not protected by an arrester.

EXCLUSIVE

peak currents obtain for an extremely short period of time so that the charge, measured in coulombs ($I \times t$), would appear to give a more accurate picture of the damage to be expected.

McEachron[2] has plotted data obtained with an oscillograph and a fulchronograph that show the total charge may exceed 160 coulombs in a few per cent of all lightning strokes measured. Fifty per cent of strokes are in excess of 15 coulombs, and only 10 per cent in excess of 90 coulombs. Further, the current peaks of a lightning stroke usually account for only a small portion of the total stroke charge. Accordingly, the highest charge in current peaks measured was 5 coulombs, and 10 per cent and 50 per cent of the strokes were in excess of 2.25 and 0.15 coulombs, respectively.

Pipe line	A *Providence Springfield Hartford*	B *Buffalo Syracuse Elmira Binghamton*	C *Paulsboro, New Jersey Midland, Pennsylvania*	D *Malvern, Pennsylvania Binghamton, New York*	E *South Portland Maine Bangor, Maine*
Date completed	1931	1940	1947	1948	1949
Length, miles	131	279	325	182	124
Size, inches	6	6; 4	12; 10; 8; 4	8	6
Coating type	Asphalt	Asphalt	Waterworks enamel	Asphaltmastic	Asphaltmastic
Coating resistance* (Ohms/sq.ft.)	2700	5000	275,000	1,400,000	1,400,000
Insulated joints	11	29	61	28	20
Joint failures	0	0	8	15	0
Joint failures—0/0	0	0	13	54	0

*Effective coating resistance calculated from average value for potential drop across coating and cathodic protection current.

Combining McEachron's data with that of Lewis and Foust, a simple calculation indicates that in the most severe lightning strokes observed (160,000 amp; 160 coulombs), peak current could be maintained for a maximum of 0.001 sec, but that, actually, current peaks have a maximum duration of 0.000032 sec.

In view of these data it is extremely unlikely that even the most severe direct lightning stroke to an exposed valve body can account for the burning of insulated joints as has been described. It appears necessary, therefore, to consider power follow current, originating with struck electric transmission or distribution lines, as a probable cause of burning. Similarly, the burning of electric transmission conductors during lightning storms is generally attributed to power follow current rather than to the lightning itself.

When a conductor of an electric transmission line is struck by lightning, potentials may be sufficient to cause a flashover between it and a tower. Normal air resistance is lowered and current from the conductor will follow the fault and the tower to earth. The resulting power follow current is limited only by the line voltage and the resistance of the fault and of the tower footings. Enormous currents continue to flow until circuit breakers can react to de-energize the conductors. Modern breakers are designed with interrupting speeds[3] ranging from 3 to 8 cycles, whereas older type breakers require up to ⅓ sec, or 20 cycles, to react. Other devices utilized to control power current are protector tubes and ground-fault neutralizers.

Overhead ground wires are used extensively to intercept lightning strokes and thus prevent flashovers and subsequent power follow currents. If tower footing resistances are sufficiently low they are effective for all but about 1 per cent of lightning strokes for lines with voltages of 66 kv or higher.[4]

Although direct evidence is not available it appears logical, in view of the facts considered, to assume that power follow current does account for burning of insulated joints in intersecting or paralleling pipe lines.

Referring to the data in the table, it will be noted that the ratio of insulating joint failures increases with the

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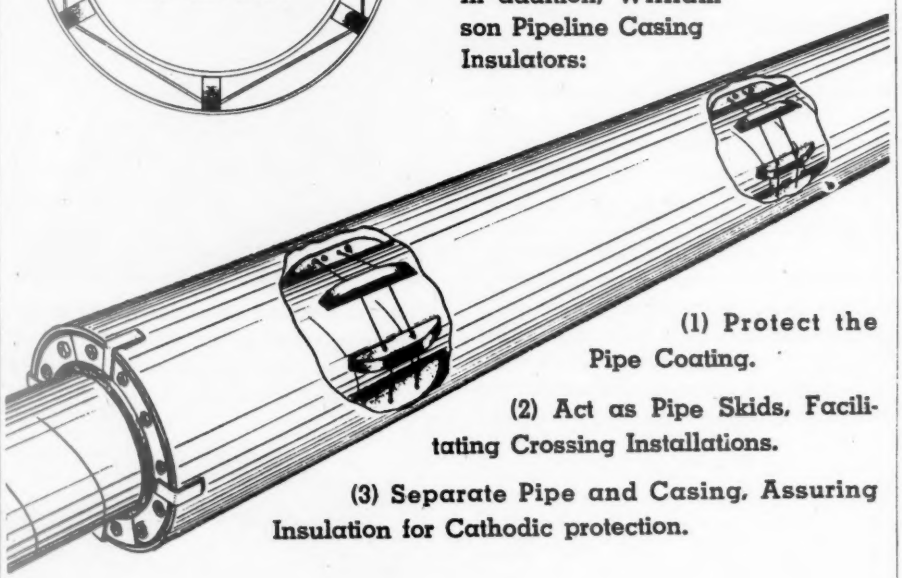

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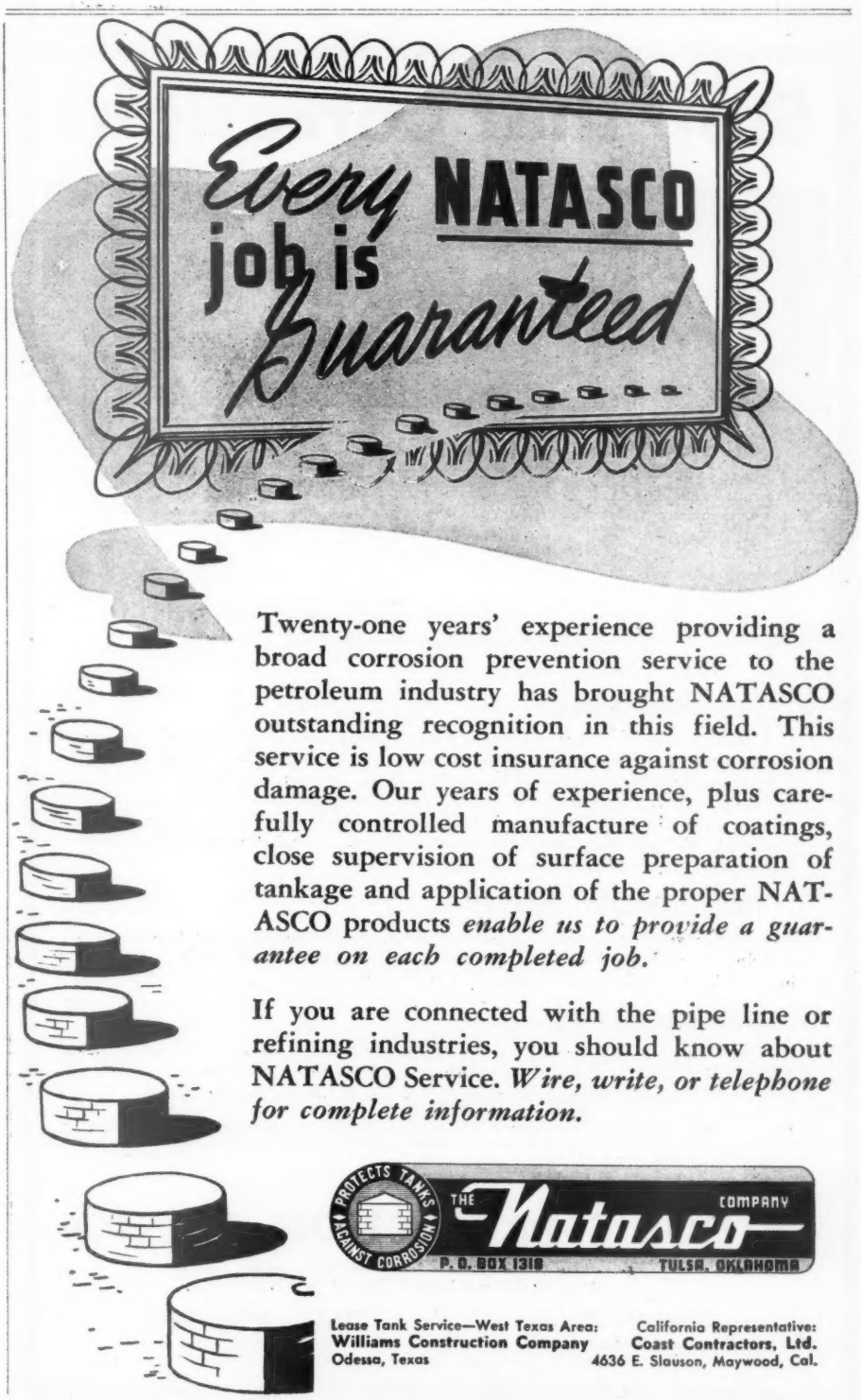
effective resistance of the pipe coating. Pipe line E (South Portland-Bangor, Maine) is an exception readily explained by the relatively few high voltage transmission lines intersected. Pipe lines A, B, C, and D in New England, New York, and Pennsylvania are comparable with respect to such intersections. We have experienced no failures among 40 insulated joints in 310 miles of pipe line in New England and New York where effective coating resistances are 2700 and 5000 ohms per sq ft, respectively. Welding has occurred in 8 of 61 joints in three years, and in 15 of 28 joints in a single season in 507 miles of line in Pennsylvania having effective coating resistances of 275,000 and 1,400,000 ohms per sq ft, respectively.

Power follow current, entering the earth through a fault and tower footings, will seek the lowest resistance path to a sub-station or generating plant where it originated. If geographic relationships are favorable, long sections of buried pipe line may be included in the electrical circuit. Other factors being equal, well-coated lines will conduct a smaller proportion of the total current than those having lower effective coating resistances. In the case of bare or poorly coated lines, current encountering an insulated joint will simply be bypassed through the earth. The high coating resistance of well coated lines, however, will promote the development of potentials sufficiently high to cause arcing at the phenolic insulating materials of a joint.

Design specifications for our newer pipe lines have provided for insulated joints, installed during construction, at terminals, junctions, pumping stations, major river crossings, and other strategic locations as determined by experience and a preliminary survey of the right-of-way. No. 00 insulated cables are brazed to the pipe on each side of the insulated joint, brought a few feet above grade through a 2-in. steel pipe riser, and fitted with lugs that terminate in a housing consisting of a 3-in. reducer, cap, and nipple, the latter 8 in. long. When these lugs are taped individually, the joint is effective immediately in limiting strays and long line galvanic currents. Later the joint may be left effective, short circuited, or a resistance may be inserted to suit the requirements of stray current drainage bonds, forced drainage or sacrificial anodes, as determined by field tests. Buried insulated joints are boxed in asphalt or enamel; those in concrete valve pits are not coated.

High costs of replacing insulating materials in joints, short-circuited by power follow current, suggested the use of lightning arresters in the existing No. 00 cable circuit at each insulated joint location. Commercial types, appearing to be suitable for the high voltages and currents encountered, were bulky and expensive. We have, therefore, devised an inexpensive and simple arrester which has proved to be reasonably satisfactory for our purposes. The ordinary soldering lugs were replaced with an assembly consisting of two No. 1-2/0 T & B Lock-Tite lugs separated by a strip of mica 0.004 in. to 0.008 in. thick and containing 8 or 10½ in. perforations. The lugs are held in position by a No. 10 machine screw, insulated from the copper lugs by a phenolic sleeve and washers. The steel housing is effective in confining the heat generated during a flashover in terminals or other hazardous areas. Fig. 3 shows a typical arrester assembly with protective housing removed.

Arresters have been entirely effective during the past eight months in preventing burning and welding of insulated joints. During the seasons when lightning storms are prevalent it is necessary to inspect the arresters regularly and to repair those that are welded. A millivoltmeter is used for testing and badly burned lugs are re-



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placed readily with an Allen wrench. If welding is not severe, the lugs are broken apart, their faces filed smooth, and the arrester reassembled for further service.

Fig. 4 shows mating lugs of an arrester found to be welded at two points. Many arresters inspected show evidence of mild arcing without welding and this suggests that the thickness of the mica separator may be increased, to reduce arrester maintenance costs, without endangering the insulated joint.

The ease with which our arresters may be inspected should provide ready means for continued study of the problem. Although direct measurement of potentials and current rates and quantities requires specialized equipment not presently available to us, a statistical study should be informative. Frequency of arcing and welding at the insulating joint arresters may be correlated with the proximity of electric transmission and distribution lines, with types of protective devices employed against lightning, and, with records of circuit breaker action, because of lightning flashover, at generating plants or sub-stations.

Caution must be exercised in the installation and maintenance of insulated joints and lightning arresters in well-coated pipe lines. Undoubtedly, fatal voltages and currents can exist. On clear days the hazard is reduced but there still may be a danger from remote lightning storms if the pipe line system is extensive. Where practicable, the joint or arrester should be short-circuited with a heavy jumper. The use of insulated tools is helpful. Direct and simultaneous handling of the separated lugs of the arrester should be avoided. Our engineers, who have seen burned flanges and arresters, approach and handle them with a satisfactory degree of respect.

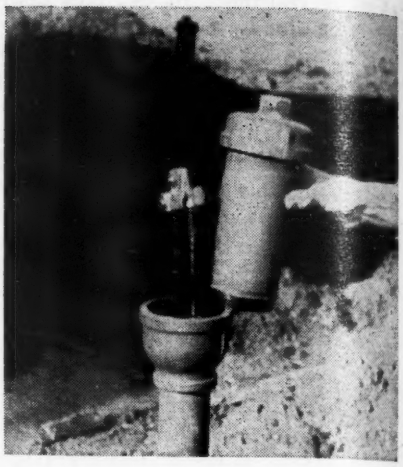

FIG. 3. Arrester assembly—2-in. steel pipe riser protects #00 insulated cables brazed to pipe on each side of insulated joint.

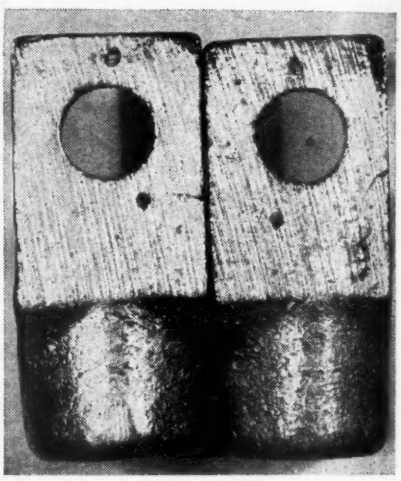

FIG. 4. Shows points of welding on mating lugs of an insulating joint arrester.

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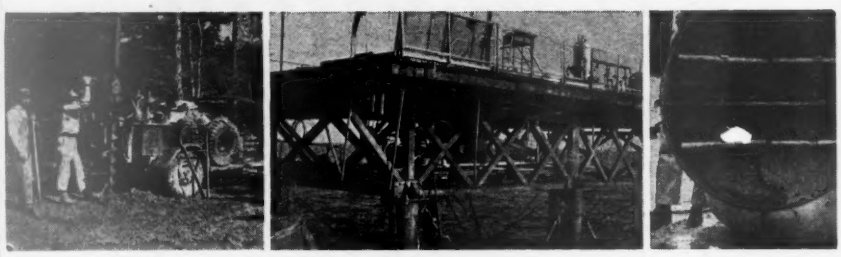

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WESTERN is furnishing the Shell and Tube Jacket Water Coolers for the engine driven pump stations on this Mid-Valley line

Full capacity of the line to Cincinnati will be about 150,000 bbl. a day, with a capacity of 140,000 bbl. a day at the Lima terminus. The project includes construction of seven main pumping stations, two spur-line pumping stations, and four oil terminals, as well as the laying of 1000 miles of pipe.

WESTERN FURNISHES HIGH PRESSURE GAS COOLING COILS FOR TENNESSEE GAS 1950 EXPANSION PROGRAM

Continuing its expansion program, Tennessee Gas, in 1950, will extend its existing system by construction of approximately 395 miles of 26-in. main line from northeastern Kentucky to the vicinity of Buffalo, New York; construction of 909 miles of second and third loops along the existing main line in Texas, Louisiana, Arkansas, Mississippi, Tennessee, Kentucky, and West Virginia; and additional compressor units. The increased capacity of the Tennessee system will be 340,000,000 cubic feet daily.

WESTERN is furnishing the major portion of the gas cooling coils on the TGT system as it did in the years 47-48-and 49.

WESTERN LUBE OIL AND ENGINE WATER COOLERS TO GREAT LAKES PRODUCTS PIPELINE

In order to meet traffic needs, Great Lakes Pipeline Company is now laying 1298 miles of 12-in. line, and 150 miles of 8-in. pipe, along existing routes, together with attendant pumping stations.

WESTERN has been awarded the contract for furnishing cooling equipment for this tremendous products line.

When completed the Great Lakes system will have a daily capacity of 176,200 bbls., approximately double its present capacity

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NEWS

Short Course Plans Diversified Program

Streamlined changes in the program of the Silver Anniversary meeting of the 1950 Southwestern Gas Measurement Short Course, April 11, 12, and 13, will give a balanced and more diversified list of subjects taught. With the exception of the first morning, the general sessions will be discontinued and classroom work will replace the talks of a general nature that have been given heretofore.

The chairman of the general committee, W. H. Woods, division gas engineer, Gulf Oil Corporation, Houston, Texas, will preside. He will introduce, W. H. Carson, dean of the College of Engineering and chairman of the executive committee of the Short Course, who will outline the aims and operation of the course. The address of welcome will be given by Dr. G. L. Cross, president of the University of Oklahoma, after which the principal address of the Short Course will be made by J. H. Russell, vice president, Gulf Oil Corporation, Houston, Texas.

Those in attendance will be called together each morning for a short period in order to give the chairman of the program committee, Ben F. Worley, United Gas Corporation, Shreveport, Louisiana, an opportunity to outline the subjects that will be taught for the remainder of the day. The group will then be dismissed, and those wishing to attend one of the several classes given during a 50-minute period may do so. Others who desire to confer with representatives of companies that have educational exhibits will be given an opportunity to obtain individual instruction in this manner.

The formal course work will be given by instructors who have been selected for outstanding achievement in their field of work. These men will come from industry, manufacturing companies, and from the faculty of the College of Engineering at the University of Oklahoma. During each period classes on fundamental practices and advanced subjects will be available for those in attendance.

It is expected that last year's record enrollment of 844 will be exceeded this year.

Several new classes with titles that have not appeared in former programs will be listed as being offered during the 25th annual Southwestern Gas Measurement Short Course. Programs will be distributed by Miss Kate A. Niblack, chairman of the publicity committee, Oklahoma Utilities Association, Biltmore Hotel, Oklahoma City.

Caterpillar Tractor to Build a New Factory

Caterpillar Tractor Company, Peoria, Illinois, announces that it has acquired approximately 300 acres of unimproved land near Joliet, Illinois, on which it will immediately start construction of a new factory in which will be manufactured a large portion of the company's extensive line of bulldozers, scrapers, wagons, and rippers.

It was not until 1945 that Caterpillar produced the first of its own bulldozers, scrapers, wagons, and rippers. Because of the lack of adequate space in its Peoria plant, only a few component parts have ever been manufactured there. Fabrication has been handled for Caterpillar by subcontractors with final assembly at the Peoria plant.

In March, 1946, Caterpillar announced a multi-million dollar expansion program that has added approximately 2,100,000 sq ft of floor space to its Peoria plant. None of this expansion was to provide for the manufacture of earth-moving equipment. At the beginning of this year, that vast project was virtually completed.

The new plant at Joliet marks an additional expansion of manufacturing facilities with which it is planned to achieve the greatest possible economy in the manufacture and distribution of Caterpillar products. In addition to its main plant at Peoria, Illinois, Caterpillar has a factory and parts depot at San Leandro, California, and parts depots at Kansas City, Kansas; Atlanta, Georgia; Shreveport, Louisiana; Albany, New York; Minneapolis, Minnesota; Spokane, Washington and Indianapolis, Indiana.

T. R. (Ted) Farley

L. B. Neumiller, president of the Company, stated that "for several years the company's facilities at Peoria have been, presently are, and it is contemplated will continue to be completely burdened with the manufacture of tractors, diesel engines, motor graders and replacement parts, requiring a continuing, or possibly even higher, level of employment in that city."

In view of the great importance of Caterpillar products to the military, decentralization, rather than the further concentration of manufacturing facilities in the Peoria area, was one of many factors leading to the selection of the Joliet site.

T. R. (Ted) Farley, vice president, has been named general manager of the new plant.

In 1940, Farley was elected vice president of Caterpillar Tractor Company and in early 1942, he also became vice president of Caterpillar Military Engine Company, a wholly-owned subsidiary of which he was later president.

East Coast Natural Gas Conference Held

The East Coast Natural Gas Conference, sponsored by Malcolm W. Black and Company, Inc., was held in New York City January 23, 25, 27.

Each day the meetings started at 9:30 a.m. and officially ended at 4:30 p.m. with an open forum panel extending for about an hour after the 4:30 closing and all interested were encouraged to attend and most did.

The same subject was covered each day—the purpose of the three days was so the utilities could arrange to have one-third of the people they wished to attend at a time, permitting as little disturbance as possible to their normal operations.

The program was as follows:

E. N. Armstrong, superintendent of measurement, Transcontinental Pipe Line Company, Houston, Texas.

1. Design and maintenance of gas measurement and control equipment.
2. Manufacturing techniques of the gas meter station.

P. H. Miller, superintendent of measurement, Texas Eastern Transmission Corporation, Shreveport, Louisiana.

1. Quality and quality control of gas measurement,
2. Gas measurement panel.

K. R. D. Wolfe, vice president, Fisher Governor Company, Marshalltown, Iowa.

1. Fundamentals of gas pressure regulators in conjunction with distribution of natural and manufactured gas,
2. Operation and application of regulators.

The question and answer panel was headed by E. N. Armstrong, P. H. Miller, Paul A. Elfers, vice president, Fisher Governor Company, W. A. Griffin, vice president of Daniel Orifice Fitting Company, Houston, Texas.

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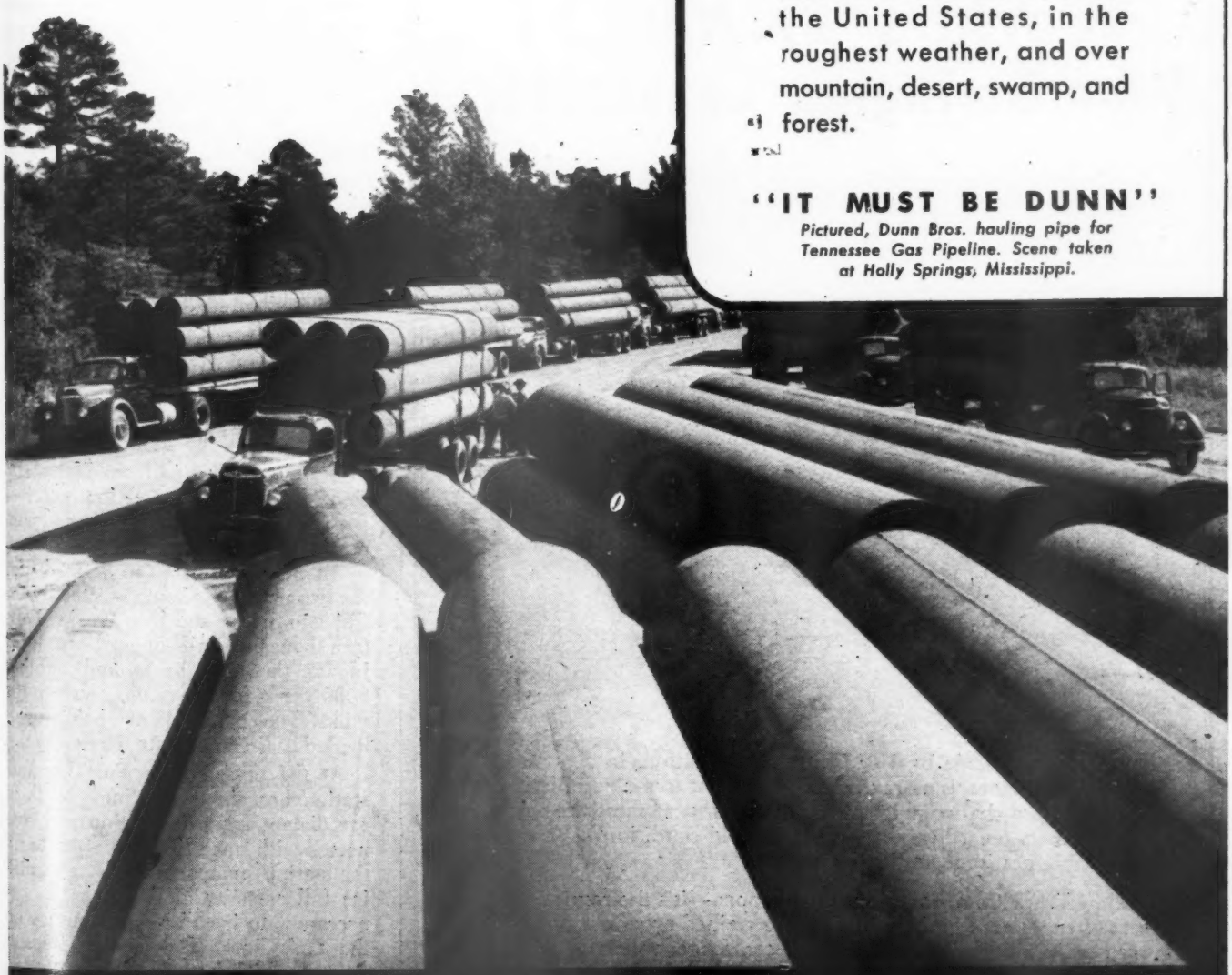
Pictured, Dunn Bros. hauling pipe for Tennessee Gas Pipeline. Scene taken at Holly Springs, Mississippi.



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O. C. Whitaker Company, Contracting Firm, Sold

The O. C. Whitaker Company, well known pipe line contracting firm of Fort Worth, Texas, has been acquired by the Southern Contracting Company, according to a recent announcement. Headquarters will remain at 804 Dan Waggoner Building in Fort Worth.

Officers of Southern Contracting Company are: Robert Thomas, president; I. C. Little, Sr., vice president; J. C. Briscoe, vice president and secretary-treasurer, and J. C. Minyard, general superintendent.

Stanolind Revamps Its Fort Laramie Station

To improve handling of Wyoming crude oil, Stanolind Pipe Line Company's Fort Laramie station recently was revamped and transferred from the company's Nebraska to its Wyoming division, J. R. Polston, general manager, announced. Formerly under Area Superintendent W. S. Partner of Scottsbluff, Nebraska, the station now is under Area Superintendent R. R. Strand, Casper.

As a traffic engineer now is headquartered at Casper to expedite oil dispatched through Fort Laramie station, the division transfer will bring closer coordination of oil movement, Polston said.

An extensive construction program is nearing completion at the station. Two 46,375-bbl steel tanks, two skid-mounted 300-hp Cooper Bessemer pumping units and two 25-hp suction booster pumps are being installed to supplement present facilities.

The skid-mounted pumping units will be used as a spare and will only be operated when one of the present older units is shut down for repairs. This will allow maximum pumping capacity at all times and permit efficient maintenance of operating machinery.

The two portable units have been mounted on 25 ft concrete slabs in a temporary wooden and sheet-iron structure near the pump station. The combined capacity of the two portable units is 1400 bbl per hr at 700 psi pressure.

Fort Laramie is a "hub relay control" station. It is on the main line between Welch station, Wyoming, and Mitchell station, Nebraska, being 79 miles southeast of Welch station and 42 miles west of Mitchell. One of Stanolind Pipe Line Company's 98 main line stations, Fort Laramie is on the company's Wyoming-Freeman, Missouri, line. At the Missouri station connection is made to Stanolind Pipe Line Company's Gulf Coast-Chicago line. The company, one of the largest pipe line systems in the world, has 11,300 miles of lines in ten states.

In addition to deliveries coming through a 12-in. line from Welch station, Fort Laramie station receives from and delivers to a number of connecting carriers.

An earthen fill had to be made for the two new tanks being erected by the Chicago Bridge and Iron Works. Thirteen thousand yards of earth was filled in for the tank bases and another 8000 yards for the ramps between the tanks. The manifolds are being overhauled to accommodate the new tanks.

At the present time Fort Laramie station has six tanks. Some of them are distant from the station and connected with small lines. In order to fill the station pumps properly, and utilize full capacity of the tanks, it was necessary to install booster pumps on the tank lines. The suction booster pumps, which have been in operation since January 5, have corrected this. The two units are 25-hp electric motors that drive Johnston vertical turbine pumps.

Last items to be completed will be the tanks. Their completion dates will depend upon the weather, but should be early this year.

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This statement made by J & L Steel Corporation, in a number of national magazines, is more than a compliment to the Parkhill organization—it is a challenge to even greater effort to meet the needs of our customers regardless of weather or field conditions. We express our humble gratitude and thanks.

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H. A. Lovelady Joins Standard Pipeprotection

Herschell A. Lovelady has been appointed manager of sales for Standard Pipeprotection, Inc., St. Louis, Missouri, with headquarters at 1411 South

H. A. Lovelady

Winston, Tulsa, Oklahoma. Lovelady has been connected with the oil industry for many years in the field and sales work.

He developed a wide acquaintanceship and made many friends while manager of sales for Jones and Laughlin Supply Company in Chicago, and more recently in the purchasing department of The Texas Company.

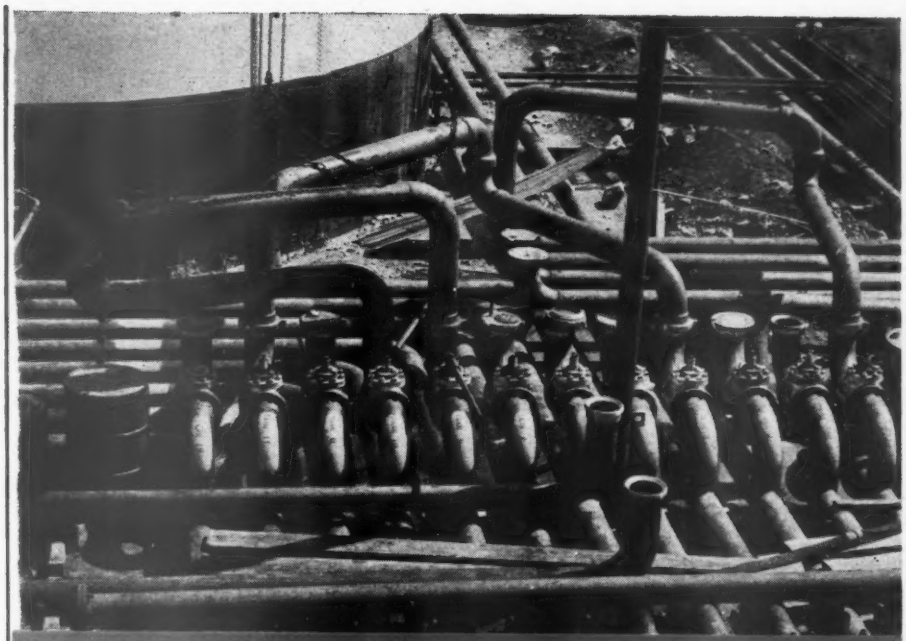
First Section of PG&E Line Placed in Operation

The first 80-mile section of Pacific Gas and Electric Company's line from Llanada, 30 miles south of Hollister, to Milpitas, near San Jose, has been completed. W. G. B. Euler, vice president and general manager of Pacific Gas and Electric Company, said that the big main has been placed in immediate operation by connecting it with the existing line from Kettleman Hills, San Joaquin Valley, to Milpitas.

Construction work now has shifted to the southern end of the route at Tapock, Arizona, just over the California border. The line will be 506 miles in length between Topock and Milpitas. At Topock it will connect with the 1100 miles of main under construction by the El Paso Natural Gas Company to Texas and New Mexico fields.

Completion of the entire project is scheduled for January, 1951, with an initial capacity of 150,000,000 cu ft daily and a contemplated delivery as high as 500,000,000 cu ft.

A. C. Holder Construction Company, 2615 East Admiral Place, Tulsa, Oklahoma, is laying 72.33 miles of 12-in. for Great Lakes Pipe Line Company, which company is paralleling its system between Minneapolis, Minnesota, and Des Moines, Iowa.



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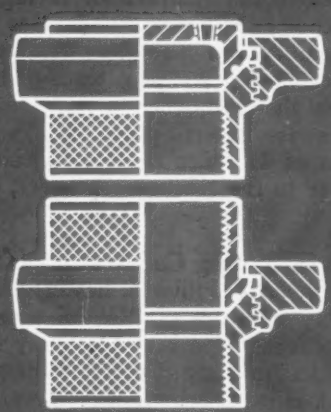

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With the PIPE LINE CONTRACTORS

O. C. Whitaker Company, 804 Dan Waggoner Building, Fort Worth, Texas, has wound up its job for United Gas Pipe Line Company, consisting of 40 miles of 20-in. between Carthage, Texas, and Sterlington, Louisiana. The line parallels an existing system. Red McMenamy and Merle Tatom were in charge of the work.

Williams Brothers Corporation, National Bank of Tulsa Building, Tulsa, Oklahoma, has been awarded the section of line between Danielsville, Georgia, and the Saluda River in South Carolina, by Fish Constructors, Inc., agents for Transcontinental Gas Pipe Line Corporation. The section consists of 86 miles of 26-in. Williams Brothers also will construct the section between Regina and Gretna of Interprovincial Pipe Line Company's system. For Great Lakes Pipe Line Company, the contractor is installing a crossing of the Mississippi River at South St. Paul, Minnesota.

Wunderlich and Griffis Pipe Construction Company, 745 Riverside Drive, Tulsa, Oklahoma, has been awarded the contract for laying two spreads on Transcontinental Gas Pipe Line Corporation's system, totaling 125 miles. Spread No. 13 extends 84 miles from the Susquehanna River to the Delaware River. Spread No. 14 consists of 41 miles from the Delaware River to the Hackensack River, New Jersey.

L. R. Young Construction Company, Olney, Illinois, has contracted to lay 42 miles of 12¾-in. pipe for The Texas Pipe Line Company from Patoka to Clay City, Illinois. The work is expected to begin in April.

Smith Contracting Corporation, 1410 Fort Worth National Bank Building, Fort Worth, Texas, is just getting started good on the 196 miles of 30-in. it is laying for Transcontinental Gas Pipe Line Corporation. Rains have slowed the work but conditions at the moment are ideal and the contractor expects to make excellent progress from now on. The section of line is in Virginia between Chatham and the Potomac River. The field office is at Altavista. R. M. Jones is spread superintendent, Ivan E. Steele secretary, and Ben L. Mapes office manager.

A contract was signed recently with Brown and Root to lay 108 miles of 16-in. between Baytown and Provident, Texas. The start on this job has been delayed by lack of pipe and work is expected to get under way about May 1.

Fred Mannix and Company, Calgary, Alberta, Canada, is laying as a joint venture with **Canadian Bechtel, Ltd.,** 441 miles of 20-in. crude oil line from Edmonton to Regina for Interprovincial Pipe Line Company. Mannix also will lay a part of 18-in. line that will parallel an existing 12-in. system between Portland and Montreal of the Portland Pipe Line Company and the Montreal Pipe Line Company, Ltd. This work is expected to begin in May.

J. E. Young Pipe Line Contractor, Inc., 931 East Rosecrans Avenue, Los Angeles, California, is laying 6½ miles of 16-in. pipe for Pacific Lighting Corporation between Newhall station and Pico Canyon. Jack Cook is project superintendent, Jimmy Coin welding foreman, Harry Hurst bending foreman, and Tommy Lindsey, Jr., wrapping foreman.

Oklahoma Contracting Corporation, 1210 Mercantile Bank Building, Dallas, Texas, will resume work about April 15 on the Salt Lake Pipe Line Company job. The original contract was for construction of 163 miles of 8-in. between Burley and Boise, Idaho, and with 100 miles laid it was necessary to shut down due to lack of pipe. With pipe shipments resumed work will soon get under way. Address Kilgore is in charge for the contractor and headquarters are at Mountain Home, Idaho.

The work for Transcontinental Gas Pipe Line Corporation in New Jersey, between the Hudson River and the Hackensack River, continues to progress, although slowly due to the nature of the areas through which the pipe is being laid. The field office is at Edgewater, New Jersey, with M. E. Shimet the superintendent.

The contractor also will lay 85 miles of 16-in. for Portland Pipe Line Corporation, the work to begin in May or June, as weather permits.

Carl H. Dunn, Burkburnett Building, Fort Worth, Texas, is completing 22 miles of 4 and 6-in. for the Texas-New Mexico Pipe Line Company in Scurry County, Texas. This line branches off the 10-in. line recently completed for the same company. The field office is at Colorado City with "Happy" White the spread superintendent. The 22 miles of 8-in. laid for Pasotex Pipe Line Company from Colorado City to a point 6 miles northeast of Snyder has been finished.

Eastern Construction Company, 1801 Mercantile Bank Building, Dallas, Texas, is doing right-of-way work in preparation for laying 155 miles of 22-in. for Mid-Valley Pipeline Company. The section is between Hornsby, Tennessee and Russellville, Kentucky. Crossings of the Tennessee and Cumberland rivers have been made. The field office is at Waverly. Fred Byers is superintendent and J. W. Arthur office manager.

Dunn Brothers, 801 Mercantile Securities Building, Dallas, Texas, (stringing contractors), continue with the stringing of 30-in. pipe for El Paso Natural Gas Company, totaling 795 miles between Jal, New Mexico, and Topock, Arizona. The crews in charge of L. L. Rowland continue to make their headquarters at Benson, Arizona, but those under John Samuels are now at Buckeye, having moved from Casa Grande.

Fish Constructors, Inc., M. and M. Building, Houston, Texas, is acting as agent for construction of Transcontinental Gas Pipe Line Corporation's system from the Lower Rio Grande Valley of Texas to New York City. Contracts have been let and work is getting under way on the section from Athens, Georgia, to New York City. The line will be completed this year, it is announced. The Fish organization is itself building the compressor stations.

H. L. Gentry Construction Company, 921 Michigan Avenue, Jackson, Michigan, is constructing 111 miles of 22-in. line for Mid-Valley Pipeline Company, between Elizabethtown and Hebron, Kentucky.

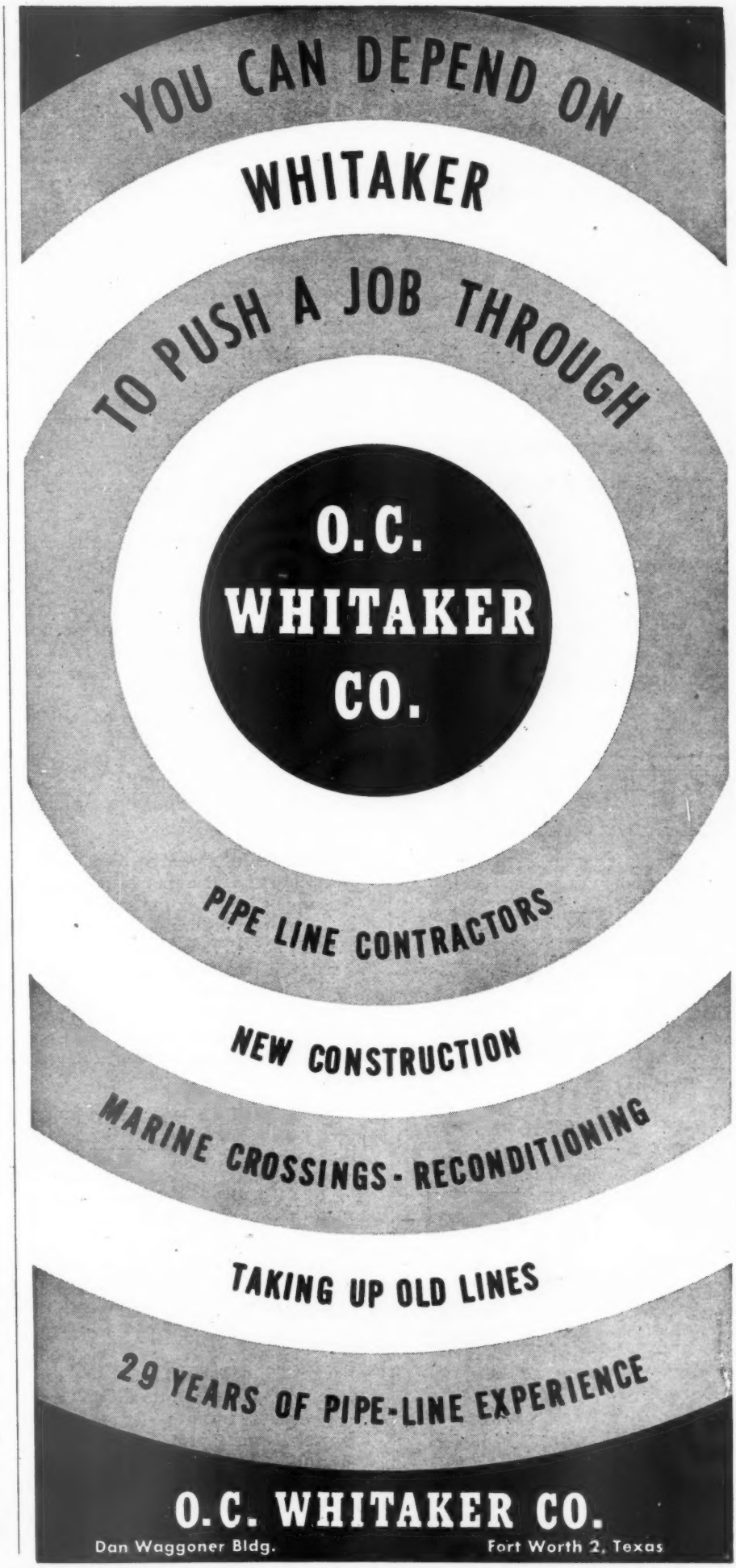
Anderson Brothers Construction Company, 707 North Drennan Street, Houston, Texas, is laying 193 miles of 18-in. crude oil line for Humble Pipe Line Company from Satsuma, Texas, to a point between Fredericksburg and Llano. This company also will construct the line between Gretna and Superior on Interprovincial Pipe Line Company's system. This will be a 20-in. line and overall will extend 1150 miles from Edmonton to Superior.

Knupp Construction Company, Inc., Great Bend, Kansas, has a project under way installing gathering lines for the Kaw Pipe Line Company that will continue through 1950. The lines are 4 in. The work is being supervised by the company's Great Bend and Plainville organizations. Doyle Praytor is the superintendent at Great Bend, Ervan Fanshier is in charge of the work near Russell, and A. D. "Dutch" Pegg is superintendent at Plainville.

Mary Construction Company, Box 205, Cape Girardeau, Missouri, will begin work about June 1 on 111 miles of 26-in. line for the Northern Natural Gas Company. The section will loop the company's line from a point near Ogden, Iowa, to Farmington, Minnesota.

Pacific Pipe and Engineers, Ltd., 2268 East Firestone Boulevard, Los Angeles, California, will begin work as soon as weather permits on a section of line between Baker and Pasco, Idaho, for the Salt Lake Pipe Line Company. This is part of a 240-mile extension of the Salt Lake City-Boise line begun last year and opened to service in January as far as Twin Falls.

Pacific also is laying approximately 300 miles of 12-in. for Great Lakes Pipe Line Company between Tulsa, Oklahoma, and Kansas City, Missouri.



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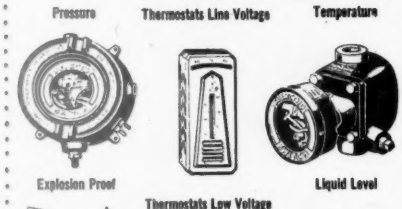

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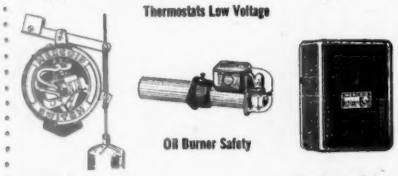

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Morrison Knudsen Company, Inc., Macco Corporation, and **Bechtel Corporation,** San Francisco, California, will begin work as soon as weather permits on 140 miles of 8-in. products line between Boise and Baker, Idaho, for the Salt Lake Pipe Line Company.

Bechtel-Price-Conyes, 220 Bush Street, San Francisco, California, has right-of-way clearing, stringing, and trenching in progress northward from Topock, Arizona, on the line being laid for Pacific Gas and Electric Company. The project, 506 miles of 34-in., is from Topock to Milpitas, California.

Deaton and Sons, Inc., Box 2928, Odessa, Texas, is scheduled to start April 1 on 104 miles of 12-in. for Montana Power Company. The line will be laid between Butte and Bozeman, Montana.

Britton Construction Company, P. O. Box 344, Russellville, Kentucky, has a 109-mile 22-in. section on Mid-Valley Pipe Line Company's crude oil line. The section extends from Russellville, Kentucky, to a point 25 miles north of Elizabethtown, Kentucky. Work will begin about March 15. The field office is at Russellville. H. R. Britton is manager, Fred N. Peters spread superintendent, E. Howard Smith, Jr., office manager, and Ed Simmons welding foreman.

Continental Construction Company, Port Lavaca, Texas, completed two submarine pipe line jobs the latter part of February. A 4½-in. line was laid across Powderhorn Lake for Brazos Oil and Gas Company, and a 2½-in. line (the first) into Corpus Christi Bay for The Texas Company. Sammy Collins, vice president of Continental Construction, was in charge of both jobs.

R. H. Fulton and Company, P. O. Box 1526, Lubbock, Texas, has two major jobs under way and will begin two others in the near future. Work began early in February on 202 miles of 30-in. for Transcontinental Gas Pipe Line Corporation from Spartanburg, South Carolina, to the Virginia line. Late in February the kick-off was made on 74 miles of 12-in. for Great Lakes Pipe Line Company in Iowa. A start will be made about April 1 on 222 miles of 26-in. loops for Northern Natural Gas Company from Perrytown, Texas, to the Nebraska line. Also for Northern Natural Gas Company, 155 miles of 20-in. will be laid from Garden City to Bushton, Kansas. This job will begin the early part of May.

O. R. Burden Construction Corporation, 6702 East Twenty-first, Tulsa, Oklahoma, was recently awarded a contract by Mid-Valley Pipeline Company covering Section 1, 110 miles of 20-in. between Longview, Texas, and Haynesville, Louisiana. Work will begin March 15 or later. Another new contract has been received from the Texas-Empire Pipe Line Company to construct 42.5 miles of 16-in. from the Wilmington, Illinois, pump station northeast to South Gary, Indiana. This work will begin about April 1.

Associated Pipe Line Contractors, Inc., 4001 Homestead Road, Houston, Texas, will construct 74 miles of Transcontinental Gas Pipe Line Corporation's system, the section from the Potomac River in Virginia to the Susquehanna River in Pennsylvania. This contractor also will lay a part of the 18-in. system between Portland and Montreal of Portland Pipe Line Company and Montreal Pipe Line Company, Inc. Work on this project, which will parallel an existing 12-in. line of the pipe line companies, will begin in May according to present plans.

Latex Construction Company, 2707 Ferndale Place, Houston, Texas, has the following construction work under contract:

Twenty-nine miles 8-in. and 10-in. crude oil line for Gulf Refining Company from Roscoe, Texas, to Snyder pool in Scurry County, Texas. J. B. Latham is superintendent; W. E. Bayles, office manager. Headquarters are at Loraine, Texas. This job is in progress.

Fifteen miles of 6-in. gas line for Tennessee Gas Transmission Company near Tomball, Texas. H. L. Leake is superintendent and Sam B. Harrison office manager. Headquarters are at the Latex warehouse, West 11th Street, Houston, Texas. This job started March 1.

Red River crossing consisting of 7000 ft of 6-in. crude oil line for Gulf Refining Company near Grand Bayou, Louisiana. H. E. Murphy is superintendent; J. B. Stoddard, office manager. Headquarters are at Bossier City, Louisiana.

Brodie Construction Company, P. O. Box 2064, Amarillo, Texas, has established a field office at Bethany, Missouri, to lay 37 miles of 12-in. for Great Lakes Pipe Line Company. The section extends from a point south of Bethany to across the Iowa line. The superintendent is A. T. Rathjen and the pipe foreman Bill Finn. This job got under way March 1.

Morrison Construction Company, P.O. Box 798, Austin, Texas, is engaged in laying 178 miles of 18-in. crude oil line for Humble Pipe Line Company from Kemper, Texas, to a point between Fredericksburg and Llano. This is a part of Humble's system from Kemper in West Texas to Satsuma on the Gulf Coast.

Sheehan Pipe Line Construction Company, 529 National Bank of Tulsa Building, Tulsa, Oklahoma, has under contract 104 miles of 12-in. for Great Lakes Pipe Line Company in Minnesota, 52 miles between St. Paul and Faribault, and 52 miles from that point to Albert Lea.

Midwestern Constructors, Inc., 105 North Boulder, Tulsa, Oklahoma, has contracted with Northern Natural Gas Company to lay sections 6 and 7 on its new project. Section 6 consists of 43.4 miles of 26-in. between Palmyra, Nebraska, and Oakland, Iowa; section 7, 65.9 miles of 26-in. northward from Oakland.

The engineering work was done on the gathering system of Plains Natural Gas Company, consisting of 80 miles of 4 to 24-in. For this job the field office is at Liberal, Kansas, with Lyle S. DeWitt chief inspector.

Parkhill Truck Company, Box 1856, Tulsa, Oklahoma, (stringing contractors) is stringing 234 miles of 12-in. pipe on the Great Lakes Pipe Line Company job between Tulsa and Kansas City, Missouri. The general contractor is Pacific Pipe and Engineers, Ltd., of Los Angeles.

In the East the company is stringing 196 miles of 30-in. for Smith Contracting Corporation on the Transcontinental Gas Pipe Line Corporation job between Chatham, Virginia, and the Potomac River.

Trojan Construction Company, Inc., P.O. Box 4427, Oklahoma City, Oklahoma, is working two spreads on 72 miles of 12-in. for Great Lakes Pipe Line Company, extending northward from North Kansas City, Missouri. Two field offices have been opened. At North Kansas City Swede Tillotson is superintendent and Vernon Yeager office manager. At Cameron, Missouri, Maurice Crawford is superintendent and John Miller office manager. Both spreads have started (March 1) and will be finished within 30 days.

Another section of line is also being laid for Great Lakes, 48 miles of 8-in. between Cushing and Tulsa, Oklahoma. This job began March 5 and will be completed in about 45 days. A filed office has been opened at Sapulpa with Al Johnson the superintendent and Walter Wells, office manager.

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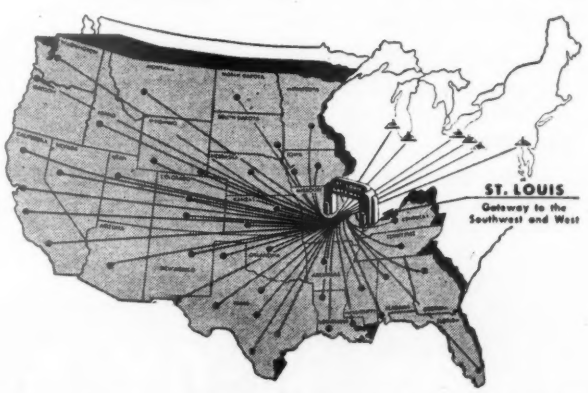

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● Here are the high points of a discussion recently held between a Dearborn representative, who *asked* the questions and an executive engineer of a major gas line who supplied the *answers:*

Q. How long have you used NO-OX-ID? **A.** Ten years.

Q. Uninterruptedly? **A.** Yes.

Q. Have you ever been disappointed? **A.** Certainly not, the results have been good.

Q. Can you name a specific performance? **A.** Yes, 10 years without a leak or replacement with soil resistance at 750 to 1200 ohms per cubic centimeter.

Q. What protection did you use prior to NO-OX-ID and what was your experience? **A.** Another coating that gave us an average pipe life of two years.

Q. Comparatively speaking, have you found NO-OX-ID applications cost less? **A.** Yes, not only with maintenance crews but some contractors on "big inch" lines have bid an average of five cents per foot less.

This is typical of the regard of users for NO-OX-ID Rust Preventives in every pipe line service.

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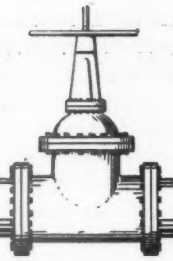
PIPE LINE PROJECTS



Roanoke Area to Get Gas for First Time

The Federal Power Commission has authorized Virginia Gas Transmission Corporation and Roanoke Pipe Line Company to construct pipe line facilities that will carry natural gas to the Roanoke, Virginia, area for the first time.

Virginia Gas Transmission, of Charleston, West Virginia, will construct a metering and regulating station at a point on its main line near Gala, Virginia, and Roanoke Pipe Line Company, of Roanoke, will build a 30-mile, 8-in. line extending from the Gala connection to Roanoke Gas Company's existing distribution facilities in Roanoke.

Estimated cost of the construction is $12,500 for Virginia Gas and $596,800 for Roanoke Pipe Line Company.

Roanoke Gas Company estimates a need for 637,000,000 cu ft of gas in 1950, increasing to 1,192,000,000 cu ft in 1953, and expects to reduce its rates immediately by $200,000 a year. The company now distributes manufactured gas.

The Commission conditioned its order by requiring Roanoke Pipe Line Company (1) to submit a tariff and service agreement satisfactory to the FPC at least 60 days prior to commencement of operations; and (2) to submit a satisfactory plan for financing the project prior to the consummation thereof.

Permission for Merger And New Line Sought

The Federal Power Commission has been asked to authorize Colorado Interstate Gas Company (1) to acquire all the natural gas facilities of Canadian River Gas Company, and, contingent upon approval of the proposed merger, (2) to construct a 175-mile transmission line, which would carry additional natural gas to the Rocky Mountain market area.

The application, filed jointly by the two companies, says that the merger is necessary to enable Colorado Interstate to procure an adequate financing base for the proposed pipe line construction program, which is estimated to cost $8,645,000, plus an additional investment of approximately $3,583,000 in production and gathering facilities.

Under the proposed merger plan, Colorado Interstate will acquire all of Canadian River's outstanding common stock from Southwestern Development Company. As consideration, Southwestern will receive all the liquid hydrocarbons contained in the natural gas now owned by Canadian River in the West Panhandle field, and in other instances, marketing rights and a share of the proceeds in connection with the extraction and sale of other liquid hydrocarbons.

The 175-mile, 20-in. line that Colorado Interstate proposes to construct would extend from the West Panhandle gas field in Texas to the company's Lakin, Kansas, compressor station, and would deliver gas into the existing Lakin-to-Denver pipe line. A 4800-hp compressor station would be built at the southern terminus of the line, and a gasoline plant and dehydration plant would be constructed on the discharge side of the projected compressor station.

Colorado Interstate hopes to complete the construction in time to have the facilities available for the 1950-1951 heating season.

Colorado Interstate's home office is in Colorado Springs, Colorado, and Canadian River's is in Amarillo, Texas.

Associated Would Build Missouri Gas Facilities

Associated Natural Gas Company, of Tulsa, Oklahoma, has applied to the Federal Power Commission for authorization to build pipe line facilities in southeastern Missouri that would carry natural gas to the Sikeston and New Madrid areas. Estimated cost of the construction program is $900,000.

The company plans to build 14.5 miles of 8⅝-in. line extending from a connection with Texas Eastern Transmission Corporation's line near Oran, Missouri, to Sikeston, and 21 miles of 6⅝-in. line from Sikeston to New Madrid. In addition, the company proposes to construct gas distribution systems in Sikeston and New Madrid, with taps and connections to serve ultimate consumers in rural areas outside those cities.

Texas Company Announces New Illinois Pipe Line

A 42-mile crude oil pipe line will be constructed by The Texas Pipe Line Company from Patoka, Illinois, pump station site to Clay City, Illinois, pump station site, it is announced by R. B. McLaughlin, president of the pipe line company.

The line, which will be 12¾ in. in diam, will be built by the L. R. Young Construction Company of Olney, Illinois.

FPC Examiner Approves New York State Project

Federal Power Commission Presiding Examiner Marvin Farrington has filed a decision, subject to review by the commission, authorizing the construction and operation of pipe line facilities that will carry additional natural gas for distribution in Oswego, Onondaga, Madison, Oneida, and Herkimer Counties in New York State.

The examiner's decision authorizes New York State Natural Gas Corporation, of New York City, to install and operate a measurement station in Onondaga County and to sell and deliver additional natural gas to Niagara Mohawk Power Corporation.

Niagara Mohawk was authorized to construct and operate 16 miles of 14-in. loop line extending from New York State Natural's proposed measurement station to a connection with Niagara Mohawk's existing system near Syracuse, New York.

The application proposing these latter facilities originally was filed jointly by Central New York Power Corporation and New York Power and Light Corporation. New York Power and Buffalo Niagara Electric Corporation subsequently merged with Central New York Power, which survived as the Niagara Mohawk Power Corporation.

Plan Gas Line in Tennessee

A $11,640,000 contract has been signed to build a natural gas pipe line in Tennessee. Oman Construction Company of Nashville and the N. A. Saigh Company of San Antonio, Texas will share in the contract, Wade Thompson, president, East Tennessee Natural Gas Company, Chattanooga announced.

Mid-Valley Awards More Contracts on Line

Contracts for the final 105-mile section of Mid-Valley Pipeline Company's 1000-mile crude oil pipe line from Longview, Texas, to Lima, Ohio, and for eight pumping stations on the pipe line, have been awarded according to announcement here today by Vice President E. F. Morrill.

This final section of 20-in. pipe line from Longview to Haynesville, Louisiana, is to be built by the O. R. Burden Construction Corporation of Tulsa, Oklahoma.

The contract for the Longview pumping station was let to Thomas Bryan & Associates, Inc., of Houston, Texas. The Haynesville, Louisiana, station contract went to Dresser Engineering Company of Tulsa. The contract for the Mayersville, Mississippi, station will be let later.

The Abbeville, Mississippi, Denver, Tennessee, and Mayersville, Mississippi, contracts were let to Refinery Maintenance Company, Inc., of Compton, California; O. L. Olsen of Houston, Texas, is to build the Clarkson, Kentucky, pumping station, and the Hebron, Kentucky, station contract was awarded to Dravo Corporation of Pittsburgh, Pennsylvania.

Radio communications contract was awarded to Motorola, Inc., Chicago.

The Mid-Valley Pipeline Company, under the joint ownership of The Standard Oil Company (Ohio) and Sun Oil Company, expects work to start in early March on the number one section of the pipe line and the various pumping stations. The pumping station contracts cover the construction of the pumping station buildings, the plumbing, the electrical wiring, grading, and landscaping as well as the installation of the heavy equipment of the stations.

Line to Charlottesville Will be Constructed

The Federal Power Commission has authorized Virginia Gas Transmission Corporation, Charleston, West Virginia, to construct and operate a metering and regulating station for deliveries of natural gas to the City of Charlottesville, Virginia.

The facilities, estimated to cost $9000, will be built on Virginia Gas Transmission's pipe line at a point near Doylesville, Virginia. The City of Charlottesville will build approximately 14.5 miles of 6-in. pipe line extending from the metering and regulating station to its existing system.

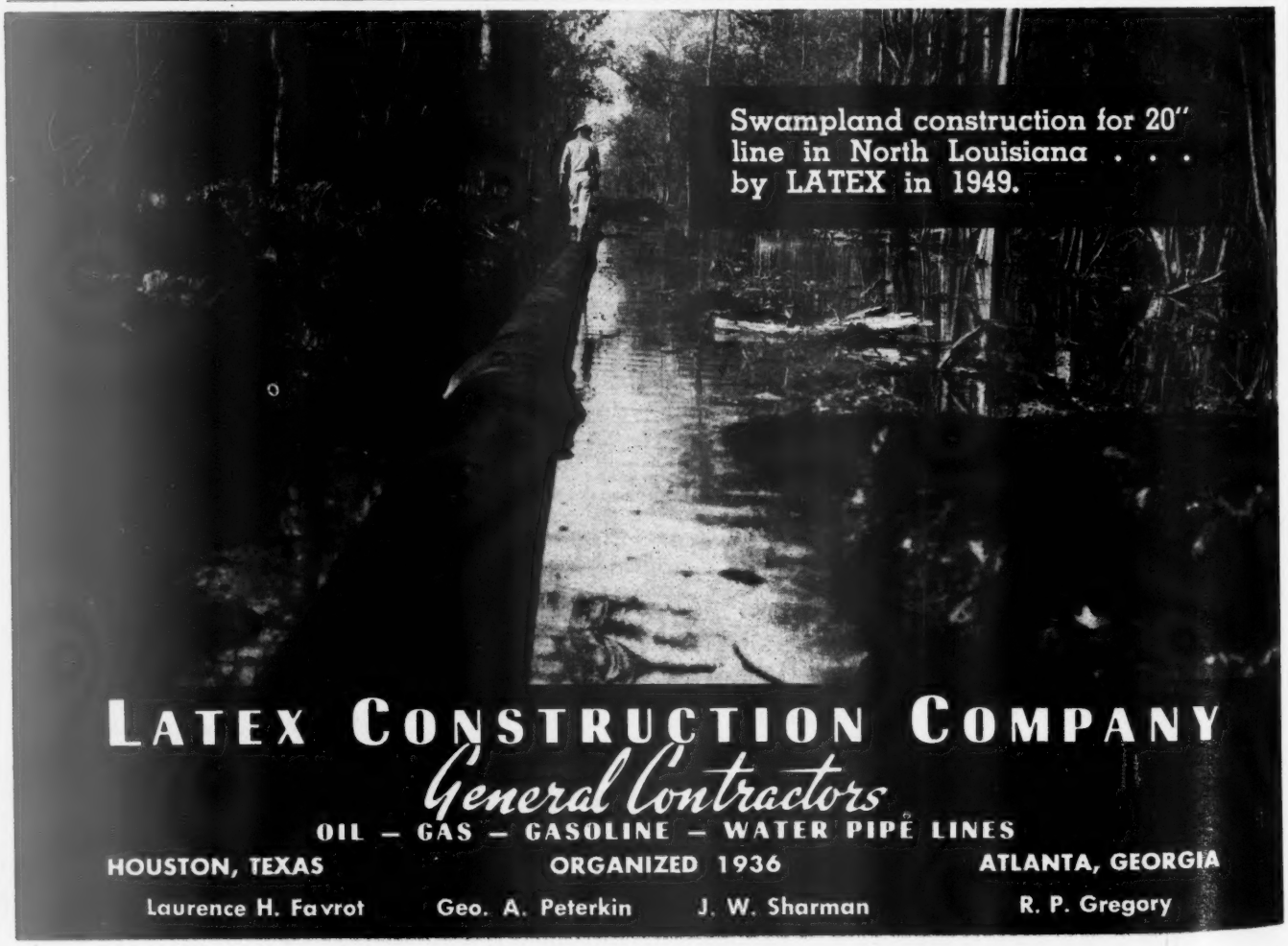
Stanolind Will Give Scurry Another Outlet

Stanolind Pipe Line Company will extend its West Texas facilities to include the northern portion of the rich Scurry area by building a 36-mile line into southern Kent County, it is announced by J. L. Burke, president of the company.

Scurry County during the last year has proved to be one of the most promising areas of development in the Permian Basin. Stanolind Pipe Line Company's new line will provide an additional outlet for the production in this vicinity and will relieve critical transportation problems for the area.

The new line is an extension of the company's present line to the Post field in Garza County. This initial extension into the area will reach into the southern area of Kent County, approximately one mile north of the Scurry County line where four new wells are producing. This is known as the Cogdell field.

With headquarters in Lubbock, the West Texas division of Stanolind gathers oil in Hale, Lamb, Lubbock, Garza, Hockley, Cochran, Yoakum, Gaines, Andrews, Winkler, Ector, and Ward Counties in West Texas, and Lea and Chaves Counties in New Mexico.


Swampland construction for 20" line in North Louisiana . . . by LATEX in 1949.
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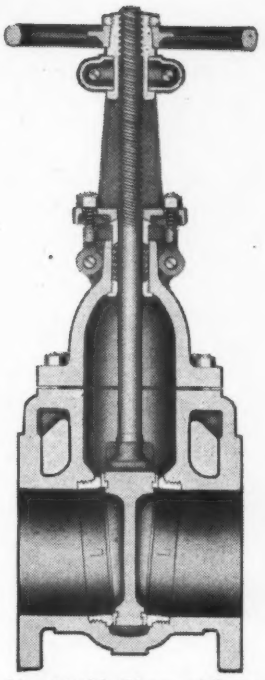

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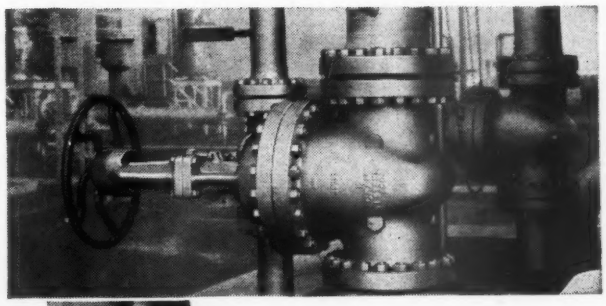
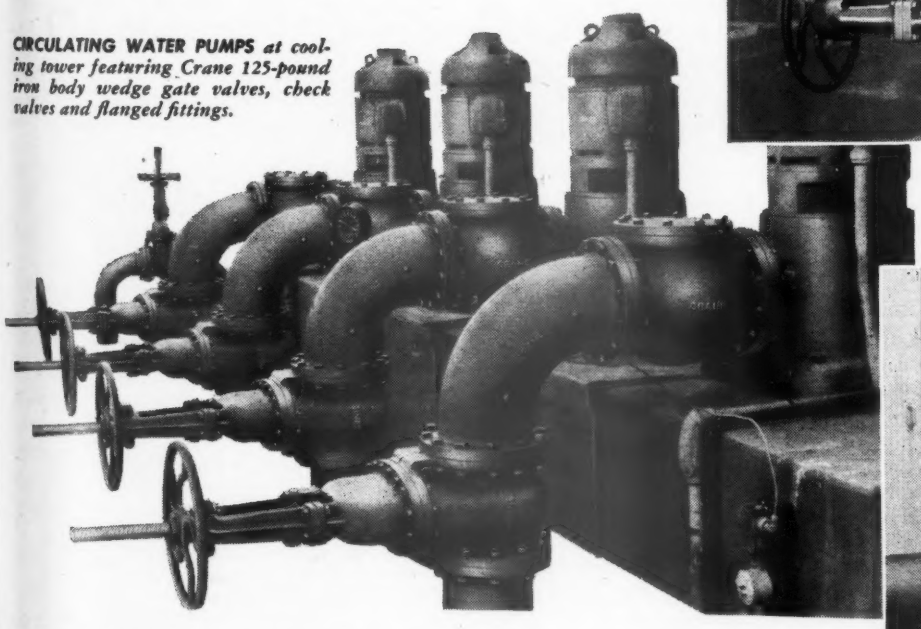
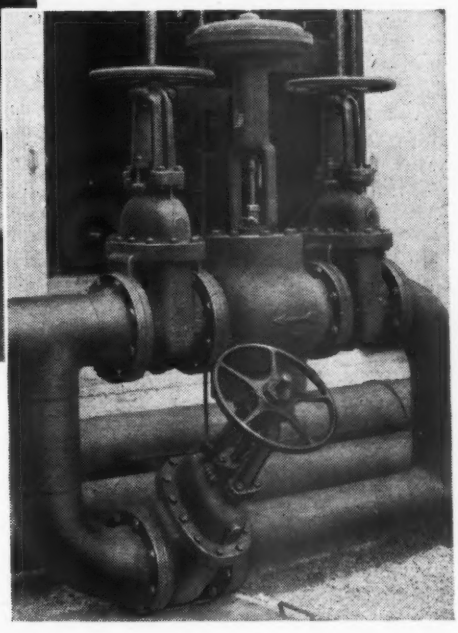


CIRCULATING WATER PUMPS *at cooling tower featuring Crane 125-pound iron body wedge gate valves, check valves and flanged fittings.*



CRUDE OIL FIELD LINES *showing regulator with Crane iron body wedge gate valves in fabricated by-pass arrangement.*



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Tennessee Gas Amends Application With FPC

Tennessee Gas Transmission Company, of Houston, Texas, has amended an application filed last August with the Federal Power Commission and is now seeking authorization to expand the capacity of its natural gas pipe line system by 250,000,000 cu ft a day to a daily total of 1,310,000,000 cu ft. Estimated cost of the project is $118,644,000.

The proposed construction would make natural gas available to companies that now distribute manufactured gas in Ohio, New York, and New England, and would provide additional quantities of gas to Tennessee's present customers or their affiliates, and to one new customer on its existing system.

The project would include a 303-mile main line extension of Tennessee's system from the eastern terminus of the company's authorized Kentucky-to-Buffalo pipe line in Erie County, New York, to a point on the New York-Massachusetts state line.

The program also involves construction of a total of approximately 786.6 miles of loop along Tennessee's existing or authorized line between San Salvador field, Texas, and Buffalo, New York; installation of compressor units aggregating 69,600 hp in existing or authorized compressor stations and 42,000 hp in seven new compressor stations; construction of approximately 75 miles of lateral gas supply lines; and check and sales meter stations on the Tennessee system.

The company expects to begin deliveries from the proposed facilities during the winter of 1951 and to complete the project by the fall of 1952.

Texas-Empire Lets Illinois-Indiana Line

A contract has been awarded by The Texas-Empire Pipe Line Company for the construction of 42.5 miles of 16-in. crude oil pipe line in Illinois and Indiana, it was announced by R. B. McLaughlin, president.

O. R. Burden Construction Corporation, Tulsa, Oklahoma, was given the contract to construct the crude carrier, which will extend from the pipe line company's Wilmington, Illinois, pump station, approximately 2 miles south of Wilmington, northeast to a point approximately 5 miles south of East Chicago.

Construction is scheduled to begin about April 15.

Mississippi River Fuel Proposes Capacity Increase

Mississippi River Fuel Corporation, of St. Louis, Missouri, has amended an application filed with the Federal Power Commission last September, and is now proposing to increase the daily sales capacity of its natural gas transmission system to 375,000,000 cu ft by installation and operation of additional compressor units in Louisiana, Arkansas, and Missouri.

The company plans to install compressor units totaling 27,000 hp in seven new stations, and additions totaling 5000 hp in two previously authorized stations. The seven new stations are to be built by a third party at an estimated cost of $5,400,000 and leased to Mississippi. The compressor facilities to be added by Mississippi to its existing stations are estimated to cost $1,351,000. Mississippi transmission system extends from northern Louisiana to Illinois.

As proposed originally in the application filed last September, Mississippi planned to increase the daily sales capacity of its system to 328,000,000 cu ft by the installation of 13,000 hp in compressor units in three new stations and additions totaling 3000 hp to two previously authorized stations.

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TRANSPORTATION PERSONALS

E. K. Hartzell, assistant to the president of Cities Service Gas Company, has been elected a member of the company board of directors. His headquarters are at Wichita, Kansas. Hartzell joined the pipe line organization of the company in Oklahoma City in 1945 after various assignments with Cities Service gas and electric operating subsidiaries in Colorado, Ohio, Virginia, and Tennessee.

Foster C. Whiteside, of Tulsa, Oklahoma, has been appointed chief engineer of Continental Oil Company's pipe line department, it has been announced at Ponca City by A. C. Wilkinson, manager.

Whiteside, who has been identified with pipe line engineering for several years, resigned as assistant chief engineer of Interstate Oil Pipe Line Company to accept the new position. He is secretary of The Pipe Liners Club of Tulsa.

Born in Granger, Texas, Whiteside attended high school in Grapevine,

F. C. Whiteside

near Fort Worth, and received a BS degree in electrical engineering from the University of Oklahoma.

Beginning his pipe line engineering career with Oklahoma Pipe Line Company, where he had a diversified background, Whiteside transferred in 1938 to Carter Oil Company, where he served in several assignments.

Whiteside went to Venezuela in 1941 as safety engineer for the Standard Oil Company of Venezuela, with the responsibility of designing, installing, and promoting a safety program. Moving to Atlanta, Georgia, on an assignment with the Plantation Pipe Line Company in 1943, he was transferred in 1945 to the engineering department of the Interstate Oil Pipe Line Company, Tulsa. Through various promotions he became assistant chief engineer of the company.

One of the newer pipe line contracting firms is the O. R. Burden Construction Company of Tulsa, Oklahoma. **Oscar Burden,** its president, is one of the old-time pipeliners, internationally known, having seen service both as an operating company official and as a participant in the construction end of the game. His entry into the contracting business in his own right came about in 1949 when he purchased the Bill Morrison Construction Company equipment, bought some new equipment, and opened up in Tulsa at 6702 East 21st Street. The company also has offices in Wichita Falls, Texas, and Shreveport, Louisiana. Associated with Burden are P. T. Thibodaux, vice president, and Jack S. Burden, secretary-treasurer.

For many years, and until 1939, Burden was connected with The Texas Pipe Line Company, during which period he served in many capacities, from laborer in a construction gang to division manager. In 1939 he went with the Panhandle Oil and Refining Company as vice president and general manager, but resigned in 1940 to do oil-well drilling as a contractor. That same year he organized the B & W Construction Company to do pipe line construction work in Oklahoma, Texas, and Louisiana. In 1941 he joined War Emergency Pipelines, builders of the "Big Inch" and "Little Big Inch" pipe lines. With WEP he served in the capacity of general superintendent, both in construction and operations.

In 1947 he went to Arabia for Williams Brothers Overseas Corporation as general manager, in charge of construction of the west half of the Trans-Arabian Pipe Line. After about six months in Arabia he was made general manager of the Trans-Arabian Pipe Line Company and had supervision of the line from the Persian Gulf to the Mediterranean. When the Palestine trouble developed, which closed down Tapline's operations for the time being, he returned to the United States, and as of January 1, 1949, accepted a position as president of Pacific Pipeline & Engineers, Ltd., of Los Angeles. A short time later, he resigned this post to enter business for himself.

W. H. Austen, district gauger at Darrow loading unit, Raceland, Louisiana, district, has retired after 39 years' service with Interstate Oil Pipe Line Company and its predecessor companies.

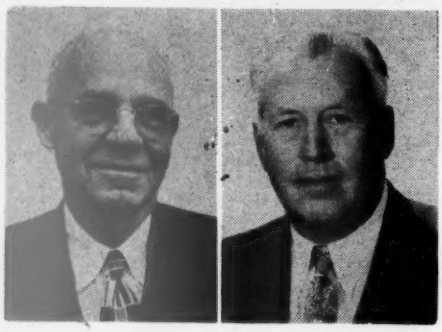
O. R. Burden

T. L. Francis has retired from his position as northern division head payroll and social security clerk of Interstate Oil Pipe Line Company, Tulsa, Oklahoma. A veteran of almost 27 years' service, Francis was first employed by Interstate's predecessor, Oklahoma Pipe Line Company, on March 26, 1923, and served in the right-of-way department while the company's offices were in Muskogee, Oklahoma. While still in the Muskogee offices, he subsequently served as clerk in the general superintendent's office and in the oil accounting department. He was an invoice clerk when headquarters of the company were moved from Muskogee to Tulsa in June, 1933. In Tulsa, Francis served as senior clerk and as payroll clerk until being named head payroll clerk on October 1, 1942. On January 1, 1945, the Oklahoma company was succeeded by Interstate, and on September 1 of the same year, Francis assumed additional duties as social security clerk.

D. M. Farrel, assistant manager of personnel and of the public relations department, in charge of safety and training for Shell Pipe Line Corporation, spoke on "Safety Training in the Pipe Line Industry" before the February 20 meeting of The Pipe Liners Club of Tulsa.

Joe W. Chana, Stanolind Pipe Line Company, is a new member of The Pipe Liners Club of Tulsa. Other recently accepted members include **Cloral O. Rains,** Phillips Petroleum Company, and **R. E. Boughner,** Rhodes Metallic Packing Company.

▸ **Laurence Andrew** has been appointed manager of the pipe line department of General Petroleum Corporation, Los Angeles, according to an announcement by **George Supple,** vice president in charge of pipe



Laurence Andrew V. C. Larsen

lines. Other changes in the department include the appointment of **V. C. Larsen** as general superintendent and **H. T. Williams** as northern division superintendent at Taft, California. **C. W. House** becomes southern division superintendent, Vernon, California.

Andrew has been with General Petroleum since December, 1912, and has spent the entire period in the pipe line department. His most recent post was as general superintendent.

Larsen joined the company in 1919 as a truck driver. He transferred to pipe line maintenance work on General Petroleum's trans-mountain lines in 1929. Since 1940 he has held the post of northern division manager and assistant general superintendent successively.

▸ **George Arterburn** has been named superintendent of Cities Service Pipe Line Company's Matfield Green compressor station near Emporia, Kansas. He succeeds **E. E. Van Laningham,** who has retired after 45 years' service. Arterburn was transferred from the Petrolia, Kansas, station. **Morris Weckerling,** a member of the engineering and construction staff since 1947, becomes superintendent of the Petrolia station.

▸ **R. J. Andress,** director in charge of traffic, Stanolind Pipe Line Company, was re-elected chairman of the Shippers Oil Field Traffic Association at the annual meeting of the group at Dallas. **W. W. Klingensmith,** manager of the Tulsa Chamber of Commerce's Traffic and Transportation departments, was re-elected secretary and treasurer, and **T. M. Moore,** traffic manager of the Atlantic Refinery Company of Dallas was re-elected co-chairman. The three officers comprise the association executive committee. Andress is serving his second term as chairman. Klingensmith has been secretary-treasurer since 1941.

▸ **Harry K. Floyd,** vice president and general manager of The Buckeye Pipe Line Company, died at his home in Lima, Ohio, on February 3. Floyd was born in Hookstown, Pennsylvania, on February 23, 1895, and began his career in the pipe line industry in 1913 with The Buckeye Pipe Line Company in its gathering line division in southeastern Ohio. In 1937 he was appointed assistant superintendent of The Buckeye Pipe Line Company, becoming superintendent in 1938, assistant general manager in 1940, and general manager in 1942. In 1948 he was elected vice president and general manager of The Buckeye Pipe Line Company and it subsidiaries—Northern Pipe Line Company and New York Transit Company, Inc. Floyd also had served as a director of The Buckeye Pipe Line Company since 1940. He was a member of the American Petroleum Institute, a 32nd degree Mason, and a member of the American Legion, having served with the U. S. Army in Europe during World War I.

▸ **A. W. Butler** has been promoted to assistant district superintendent of Magnolia Pipe Line Company's North Basin District with headquarters at Brownfield, Texas. Butler was formerly chief gauger of the company's Western Pipe Line Division.

B. B. Balke has been transferred to Midland, Texas, as chief gauger of the Western Division. He has been chief gauger of the Southern Division with headquarters at Alice, Texas.

Homer Cranfill has been advanced to chief gauger of the Southern Division at Alice, Texas.

M. E. Bay was recently transferred to Wichita Falls as assistant district superintendent of the North Texas District. Bay has been assistant district superintendent of the company's North Basin District at Brownfield, Texas.

J. S. Black has been promoted to district foreman in the West Texas District. He will make his headquarters at Snyder, Texas.

▸ **Harold C. Price,** president of the H. C. Price Company, pipe line constructors of Bartlesville, Oklahoma, sailed aboard the *Ile de France* from New York on February 10 for an extensive business trip through Europe. He will visit England, France, and Italy during his two-months' tour.

▸ **B. C. Adams, Jr.,** since 1944 a member of the executive operating staff in the Oklahoma City offices and a member of the board of directors of Cities Service Gas Company, has resigned to accept a position with Trunkline Gas Supply Company as production and purchase superintendent.

▸ **W. N. Stivers,** Stanolind Pipe Line Company engineer, has been made superintendent of the Wyoming Salt Creek district. He will exercise direct supervision over the district and will be under **R. R. Strand,** area superintendent. The company has extensive gathering systems and several delivery and receiving points with other pipe lines companies in the state.

W. N. Stivers S. L. Cox

S. L. Cox will act as area engineer for both the Nebraska and Wyoming divisions. He previously was employed only in Nebraska. His headquarters were transferred from Scottsbluff, Nebraska, to Casper.

The two divisions include all Stanolind Pipe Line Company operations in Wyoming, Nebraska, and a portion of Kansas.

Born in Chattanooga, Tennessee, in 1911, Stivers attended the University of Tulsa. He graduated in 1935 with a BS degree in petroleum engineering and joined Stanolind Pipe Line Company at Tulsa. His service with the company has been continuous.

Cox was born in Garden City, Kansas. He attended Oklahoma A. & M. College where he received a BS degree in electrical engineering. He joined Stanolind at Tulsa in 1933.

▸ **Emil J. Jandacek** has been appointed assistant chief engineer of the Texas Gas Transmission Corporation and will make his headquarters in Owensboro, Kentucky. Jandacek has been with Stone and Webster Engineering Corporation for eight years.

Other Texas Gas promotions include **James E. Allison** to the post of assistant superintendent of pipe lines for divisions 1 and 2; **John R. Harrison,** to district manager with headquarters in Owensboro, in charge of general maintenance and construction; **Ralph W. Thacker** to supervisor of payroll and office service manager, and **Frank R. Baker** to supervisor of ad valorem taxes.

▸ **T. S. Johnston,** formerly assistant to the vice president in charge of transportation and supply of Imperial Oil Ltd., has been made a vice president of Interprovincial Pipe Line.

NEWS

Texas, Louisiana Oil Flow Cut

Louisiana and Texas will be producing less oil in March than in February due to reduction in maximum permitted crude oil production for this month. Oklahoma will produce the same amount of oil, but was given a 10 per cent cut per well with new well production making up the slash.

In Louisiana, the permitted oil production has been reduced by 42,731 bbl a day, making the maximum amount 534,869 bbl daily. Texas will produce 92,161 bbl below February's output. This set the figure at 1,944,122 bbl daily. Although East Texas will pick up 36,498 bbl daily on its allowable, Districts 3 and 1—the gulf coast and West Texas areas, respectively—will be reduced sharply.

Kansas allowable has been set at 270,000 bbl daily, not including condensate. This figure is unchanged from the February level.

Ohio State Offers B PE

The Ohio State University will hereafter award the degree, bachelor of petroleum engineering, to those students who successfully complete the five-year curriculum. There also will be an award of master of science.

Middle East Oil Production Seen 10 Per Cent Above 1949

Crude oil production in the Middle East is expected to be about 10 per cent above 1949. Imports from the Middle East into the U. S. amounted to 33,483,000 bbl in the first 11 months of 1949, an increase of 15,566,000, or 86.9 per cent from the year-earler period. Imports from Venezuela, primary source of foreign crude, totaled 86,760,000 bbl, up 6,120,000, or 7.6 per cent in this period, the Bureau of Mines has disclosed. Sharpest increase in imports from the Middle East was reported for Kuwait, which shipped 17,109,000 bbl into the United States as compared with the 2,758,000 in the year-earlier period.

Arabian American Oil Company, which holds about 40,000 sq miles of oil concessions in Saudi Arabia, is expected to have a lower rate of output this year than in 1949. Plans are now that crude oil production will average about 463,000 bbl a day, down slightly from an average of 476,700 bbl daily in 1949. Anglo Iranian Oil Company, Ltd., in southwest Iran, will increase its oil production some this year, but how much will depend on such factors as the amount of oil sales British companies pick up from U. S. firms in the sterling areas of the world.

New Process to Make Steel in 12 Minutes

Working details of a new, fast steelmaking process were presented by its inventor and his collaborator before the annual meeting of the American Institute of Mining and Metallurgical Engineers. Called the "Turbo-Hearth" and sponsored by Carnegie-Illinois Steel Corporation, it was said to be capable of making open hearth-quality steel in 12 min without using external fuel. Heat is provided from chemical reaction by burning the impurities in liquid iron with a blast of air.

The men largely responsible for its present development are C. E. Sims, assistant director of Battelle Memorial Institute, Columbus, Ohio, and F. L. Toy, assistant to the manager, research and development division of Carnegie-Illinois.

Dedicate Petroleum Exhibit

The petroleum industry exhibit at the Museum of Science and Industry in Chicago, Illinois, will be formally dedicated and presented to the museum at a dinner sponsored by the Chicago Oil Men's Club, March 20, at the museum.

Robert E. Wilson, chairman of the board of Standard Oil Company (Indiana) will make the principal address; Rawleigh Warner, chairman of the board of Pure Oil, will make the presentation.

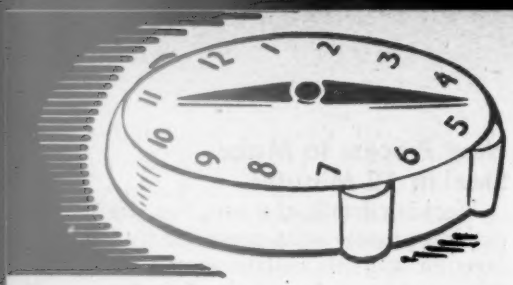
USSR Journal to Have English Translation

Complete English translation of the Journal of Applied Chemistry of the U.S.S.R. is available to American research laboratories and libraries, beginning with the January, 1950 issue, Consultants Bureau, 153 West 33 street, New York 1, New York, has announced.

The same bureau also supplies the Journal of General Chemistry of the USSR in translation.

C. D. Swift

Union Oil's Research Center. Ground-breaking ceremonies for the research center of Union Oil Company of California, below, were held January 17 in Brea at the proposed plant's 100-acre site. The $5,000,000 center will be composed of 12 buildings occupying 22½ acres and will employ 280 persons. C. D. Swift, vice president of Union Oil Company of California, shown at left, is in charge of research, development, and patents and will head the new center. The plant was designed by the architectural firm of Austin, Field, and Fry. Construction is by P. J. Walker Company, contractors; to be completed by July, 1951.



'ROUND TH
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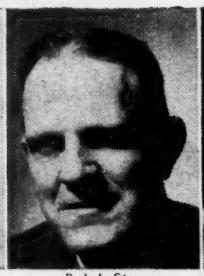
Lee Kelton
Rocky Mountains

Ed Nelson
Kansas



Ralph Stevens
Gulf Coast

Hal Fessler
Ark-La-Tex

Verne Palmer
Central States

Floyd Myers
West Texas

Joe Conrin
California

Buddy Arra
Arras Tank C

Dee Unsell
Denver

Ed Reif
Casper

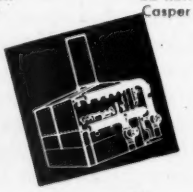
Joe Revill
New Castle

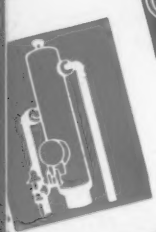
Red Doores
Craig

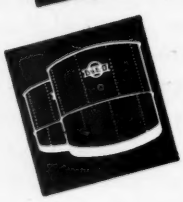
James Connor
Powell

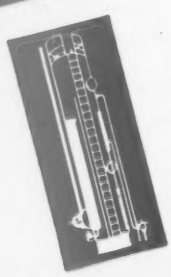
Ed Byers
Tulsa

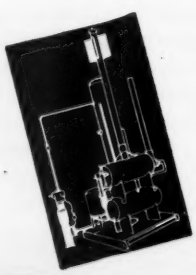
Sam Drive
Drumright











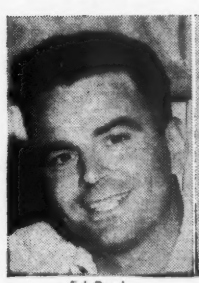
Emery Allee
Elk City

Dave Bland
Graham

Bob Sivalls
Fort Worth

Bill Watkins
Snyder

John William
Nocona



Ed Pool
Odessa

Buck Jones
Alice

Clint Ross
Lubbock

Glenn Parmlee
Houston

John Cross, Jr.
Hobbs

Ray Downing
Kilgore

Marion Miller
Wichita

Eugene Cottrell
Hays

Joe Beggs
Ellinwood

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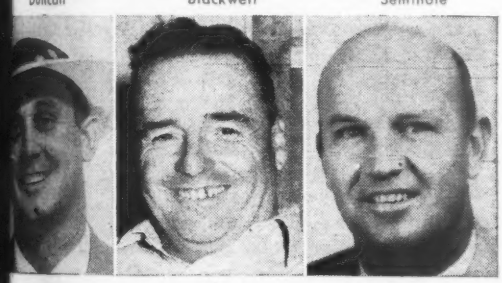

B. W. Bourne, Midland — Elvin Ryder, Borger — Charles Stevens, San Angelo

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British Restrict Dollar Oil

Despite vigorous protests from the State Department, Britain's oil restrictions against American companies have gone into effect. All exports of dollar fuel to the United Kingdom are barred, and gasoline shipments from American companies must be reduced 30 per cent, officials stated.

Texas Increases Oil Taxes

Oil and gas production taxes in Texas have increased 10 per cent. Taxes went into effect under the existing omnibus tax law. Oil now pays 4.125 per cent of market value and gas 5.2 per cent. The increase goes to a special fund for operating state hospitals.

Missouri hopes to follow Texas in increasing taxes, by raising the state gasoline tax 2 cents. The proposed tax is to be voted on April 4.

Survey Farm Fuel Use

The U. S. Department of Agriculture has published a booklet on fuel and motor oil consumption and use of tractors on the farm. Presented in the report are the estimates of annual use of tractors, together with the quantity and kind of motor fuel and the amount of motor oil used per farm tractor in 1947.

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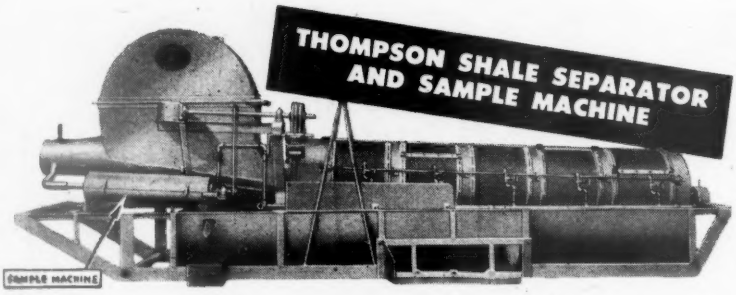

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Papers for Technical Program of NACE

Papers to be presented on technical program at the 1950 Conference and Exhibition, National Association of Corrosion Engineers April 4-7, at St. Louis, Missouri, are as follows:

Corrosion Principles Symposium, Tuesday afternoon: "The Role of Polarization in Corrosion," by G. C. English, R. D. Williams and R. H. Brown, Aluminun Co. of America. "The Influence of Stress on Corrosion," by Julius J. Harwood, Office of Naval Research.

Chemical Industry Symposium. Wednesday morning: "The Behavior of Chromium Nickel Stainless Steels in Sulfuric Acid," by George C. Kiefer and William G. Renshaw, Allegheny Ludlum Steel Corp. "Corrosion of Metals by Insecticidal Solutions," by George S. Cook and Nancye Dickinson, Engineer Research and Development Laboratories. "Corrosion in Sulfur Production—The Use of an Alloy Protective Coating," by N. Hackerman and D. A. Shock, University of Texas. "Corrosion of Metals in Fluorine and Hydrofluoric Acid," by G. C. Whitaker, Harshaw Chemical Co.

Cathodic Protection Symposium: "Design of Anode Systems for Cathodic Protection of Underground and Water Submerged Metallic Structures," by E. R. Shepard and Henry J. Graeser, Office of the Chief of Army Engineers. "A Study of Some Metals for Permanent Anodes in Water Tank Cathodic Protection Systems," by A. L. Kimmel, University of Florida. "Cathodic Protection of an Active Ship in Sea Water," by G. L. Christie, Naval Research Establishment, Canada. "The Performance of Magnesium Galvanic Anodes in Underground Service," by Oliver Osborn and H. A. Robinson, Dow Chemical Co.

Oil and Gas Industry Symposium. Wednesday afternoon: "Corrosion in Condensate and High Pressure Sweet Oil Wells," by R. C. Buchan, Humble Oil & Refining Co. "Corrosion Problems in the Modern By-Product Coke Plant," by C. F. Pogacar, Koppers Co., and E. A. Tice, The International Nickel Co., Inc. "Corrosion Experienced on a new Crude Distillation Unit at Port Arthur, Refinery of Gulf Oil Corp., by D. L. Burns, Gulf Oil Corp. "Selection of Organic Protective Coatings for Marine Use in Petroleum Production," by Jack P. Barrett, Stanolind Oil and Gas Co.

Transportation Industry Symposium: "Water Side Deterioration of Diesel Engine Cylinder Liners," by F. N. Speller, consultant, and F. L. LaQue, The International Nickel Co., Inc. "Problems in Corrosion of the

Railroads," by Ray McBrian, The Denver and Rio Grande Western Railroad. "Corrosion Problems Related to Air Transport Aircraft," by Otto E. Kirchner and Fred M. Morris, American Airlines.

Protective Coatings Symposium, Thursday morning: "Surface Preparation Values and Sandblasting Economics," by A. J. Liebman, Dravo Corp. "Flame Sprayed Plastic Coatings," by Bernard Goldberg, Schori Process Corp. "A Progress Report on the Use of Cathodic Protection in Conjunction with Paint Coatings," by William L. Crosby, Consolidated Edison Co.

Fresh and Salt Water Corrosion Symposium: "Ohio River Division Corrosion Problems," by J. A. Davenport, Corps of Engineers. "Comparative Corrosion Resistance of Killed and Rimmed Steel Pipe in Sea Water," by V. V. Kendall, National Tube Company. "Electrochemical Behavior of Zinc and Steel in Aqueous Media—Part II," by R. B. Hoxeng, Case Institute of Technology. "Cathodic Protection of Fourteen Offshore Drilling Platforms," by E. P. and G. L. Doremus, Cathodic Protection Service. "Potentials Set Up by Thermal Gradients in Iron Immersed in NaCl Solutions," by H. H. Uhlig, Massachusetts Institute of Technology, and Oscar F. Noss, Jr., Union Oil Co. of California.

Pipe Line Corrosion Symposium, Thursday afternoon: "Surface Potential Method on Corrosion Survey of Pipe Lines," by O. W. Wade, Great Lakes Pipe Line Co. "Internal and External Corrosion Experience in Shell's Products Pipe Lines," by S. S. Smith, E. H. Rush, and W. J. Curry, Shell Oil Co. "Training Program for Corrosion Technicians," by James R. Cowles, Oklahoma Natural Gas Co.

Friday morning: Pipe line protection round table and general corrosion problems round table, both consisting of extemporaneous discussions, will be held simultaneously.

Offer 16 Fellowships

The Institute of Gas Technology, as a part of its educational program, is offering 16 2-yr fellowships effective September, 1950, to qualified college seniors and graduates for the specific purpose of preparing a selected group for careers in the gas industry through graduate study, field training and research leading to the degree of master of gas technology.

Application forms and further information may be obtained from the student's departmental chairman or from the Director, Institute of Gas Technology, 3300 South Federal Street, Chicago 6, Illinois.

FTC Investigates Activities Of U.S. Oil Companies Abroad

Possible effects on the domestic industry by American oil companies abroad are being studied by the Federal Trade Commission. The FTC has issued subpœnas to secure information on the foreign operations of three U. S. firms, Standard Oil Company (New Jersey), Socony-Vacuum Oil Company, Inc., and Gulf Oil Corporation. The agency began an investigation of agreements entered into by American companies among themselves, and with petroleum companies of other countries in connection with foreign operations and with international trade in petroleum and petroleum products. The investigation comes after much controversy between importers of foreign oil and domestic oil producers. The indpendent oil producers of the country have been protesting that imports of oil have been too large and are supplanting domestic oil in the U. S. markets. Large importers have in turn, held that imports of oil are small in comparison with total demand for oil in the U. S.

Sunray-Barnsdall to Merge

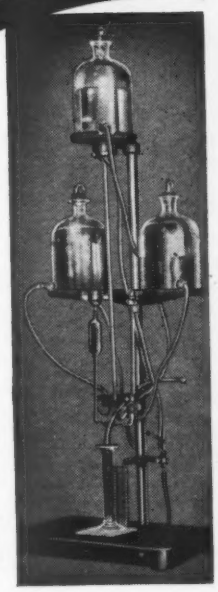
Sunray Oil Corporation and Atlas Corporation have announced the purchase by Sunray of 800,000 shares of the common stock of Barnsdall Oil Company. C. H. Wright, Glenn J. Smith, L. W. Bennett, and Edward Howell succeeded Floyd B. Odlum, George H. Howard, L. Boyd Hatch, and Oswald L. Johnston as directors of Barnsdall. Wright was elected chairman of the board of Barnsdall to succeed Odlum.

The merger is expected to follow the pattern of Sunray's previous acquisitions—Homaokla, Superior Oil of Oklahoma, Darby Oil, and Transwestern Oil. The combined companies will have combined assets of more than $250,000,000, and, on the basis of preliminary estimates, a total annual net crude production of approximately 22,000,000 bbl.

McIntosh Predicts Greater Oil Consumption in 1950

Albert J. McIntosh, Socony-Vacuum Oil Company, Inc., New York, predicted use of about 350,000 more bbl daily this year than in 1949, or a "net consumption increase of nearly five per cent." Currently more than 6,000,000 bbl are being consumed daily. McIntosh attributed a 25 to 30 per cent decrease in oil company earnings during 1949, due primarily to lower average fuel oil prices paid by consumers but added that, generally "industry conditions look good."

SULFUR and CARBON *Analyses* in PETROLEUM PRODUCTS



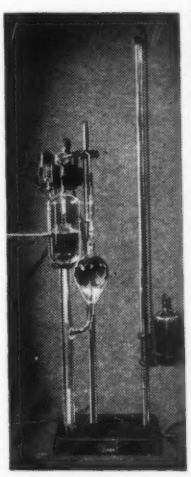
The sulfur content of oils, waxes and greases is an important measure of the value and quality of the product.

Whether the desired sulfur content be high or low, it is necessary to know exactly what amount is present.

The combustion method offers a rapid and sure means of determining sulfur in the wide range of percentages and materials encountered in the oil and grease field.

The Dietert-Detroit Sulfur Determinator embodies the correct principles of the combustion method in a simple, rugged and convenient form. Complete analysis can be made in less than five minutes.

Carbon determinations on organic compounds are being made in as little as two minutes with the Dietert-Detroit No. 3003 Carbon Determinator.



This method can be applied to any petroleum product. One example of the usefulness of this method is the analysis of cracking catalyst for carbon content.

Leading oil companies* are taking advantage of these versatile, time-saving determinators. Write to Dept. P-1 for detailed information on how you can apply rapid carbon and sulfur analysis to your problems.

*Two typical users— { THE SHELL OIL COMPANY / THE PURE OIL COMPANY

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Foreign Aid to Boost Mexican Oil Industry

Prospects for the future of the oil industry are bright in Mexico. Its accelerated program of exploration, production, and processing projects is being assisted by both American and Belgian capital. Figuring high in Petroleos Mexicanos plans for the future of Mexican oil are operations of Mexican-American Independent Company (CIMA), composed of Edwin W. Pauley, Signal Oil and Gas Company, and American Independent Company, all of California. Pauley, largely responsible for forming CIMA and getting the first contract of its kind to drill in Mexico since expropriation, said officials have plans to spend one million dollars a month in stepping up their operations.

He added that CIMA believes the Xicalango well near Ciudad del Carmen, 125 miles away from the nearest production, will develop a structure twice as large as Kettleman Hills in California. Pauley said they probably will drill at least 100 wells in the Tortuguero area as fast as the work can be financed.

Foreign guests attending the February meeting of the Houston Nomads are: Front row, Alberto Landoni, YPF, Buenos Aires, Argentina; T. R. Wilburn, Pemex, Mexico. Back row, Luis Messone, YPF; C. F. Ferrell, Gulf Kuwait; Ray Kail, manufacturers' representative, Mexico.

DeGolyer Receives Highest Petroleum Geology Award

Dr. E. DeGolyer, widely known geologist of the consulting firm of DeGolyer and MacNaughton, Dallas, Texas, has been named recipient of the Sidney Powers Memorial medal of the American Association of Petroleum Geologists. Presentation of this highest award in petroleum geology will be made April 25, 1950, as a highlight of the joint annual meeting of the American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists, to be held at the Stevens Hotel, Chicago, Illinois. Awarded in recognition of distinguished and outstanding contributions to, or achievements in, petroleum geology, DeGolyer will be the fourth geologist to receive the gold medal since establishment of the award in 1943.

DeGolyer has been eminently successful as a petroleum geologist in the finding of new oil fields, every since he found the discovery well of the Tierra Amarilla field in Mexico in 1909. The AAPG Medal Award Committee also underscores DeGolyer's contribution in introducing new methods of petroleum exploration, pointing out that it was DeGolyer who directed a torsion balance survey of the Spindletop oil field near Beaumont, Texas, in 1922. This was the first practical and successful survey of an oil-field structure in the United States by geophysical methods. Two years later, using equipment and personnel brought together and organized by DeGolyer, an unknown salt dome was discovered on the coastal plain of Texas. This discovery developed into the Nash oil field, the first geophysical discovery of a producing oil field in the United States.

As the founder and president of the Geophysical Research Corporation, DeGolyer organized and developed the research that perfected the now widely used reflection method of seismic exploration. DeGolyer also introduced the modern magnetometer into the United States.

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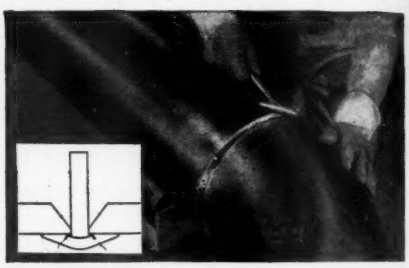
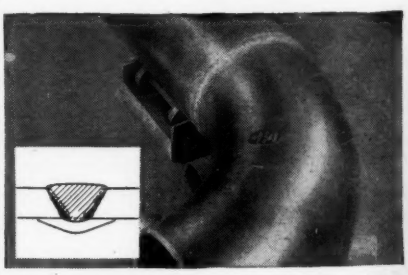
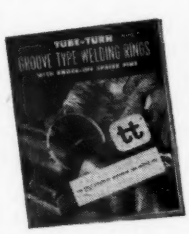
Ring snaps easily into place. Knock-off spacer pins space and center the pipe accurately and automatically.



Tacking completed, spacer pins are knocked off and the welder finishes his joint. Insert shows cross-section of ring and joint.



The finished job . . . a perfectly welded joint. Irregular black area (see insert) indicates greater width of fusion zone obtained with Tube-Turn welding ring.



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PERSONALS

Lloyd F. Thanhouser, Houston, Texas, was elected a vice president of Continental Oil Company, and will also retain his present position as general counsel. **R. L. Bosworth,** Ponca City, Oklahoma, was elected treasurer in addition to being financial vice president of the company, and **A. W. Tarkington,** former treasurer, Ponca City, was appointed assistant to the president.

Thanhouser, formerly a corporation attorney of New York City, was appointed general counsel of Continental Oil Company last year. He is a graduate of Yale University.

Bosworth has been with Continental for nearly 27 years, having joined the company as a bookkeeper in 1923. He was graduated from the University of Wisconsin.

Tarkington, joined Continental as treasurer in 1948. He attended Rice Institute, receiving his degree in commerce from Southern Methodist University.

W. D. Heath Eves was recently appointed representative of the Anglo-Iranian Oil Company in New York. He succeeds **B. R. Jackson** who is now in London as a managing director of the company. Eves attended Lancing College and Corpus Christi College, Cambridge. He worked for the Shell Company in California from 1938 to 1940 as a "rough neck," and joined the British Tanker Company in 1946 and was transferred to the Anglo Iranian New York office in 1948.

Frank D. "Dutch" Lortscher has been named manager of purchases and stores for the Signal Oil and Gas Company, according to an announcement made by S.B. Mosher, president. He will continue to make his headquarters in the Los Angeles office of the company. This promotion is one of a long series for Lortscher, who started with the company over 22 years ago on Signal Hill. Widely known in purchasing circles as well as the oil business, he has found time to take a very active interest in purchasing association work.

Frank D. Lortscher

John B. Plumb, has been elected by Sun Oil Company's board of directors as a trustee of the stock purchase plan for employees. An emloyee may invest up to 10 per cent of his basic wage in Sun common stock and for each dollar he invests the company adds 50 cents.

Plumb succeeds **William D. Mason** who resigned as stock purchase plan trustee following his recent retirement as Sun's director of industrial relations.

William R. Boyd, Jr., formerly president of the American Petroleum Institute, has set up his law office for consulting practice only, in his ranch home out of Teague, Texas. He will serve as a consultant-advisor to oil and gas company directorates, management and legal departments on matters related to public relations, inter-industry relationships, and legislation.

Frank P. Donahue, formerly head of the oil loan department, National Bank of Commerce, Houston, Texas, and **Joseph B. Zick,** formerly with Danciger Oil and Refining Company, Fort Worth, Texas, are now associated with Alec M. Crowell, natural gas consultants, Carondelet Building, New Orleans, Louisiana. They will move to the California Company Building at 1111 Tulane Avenue, New Orleans, when it is completed about October 1, 1950.

New York Nomads. Business meeting and installation of 1950 officers of New York Chapter of Nomads at Louis Sherry's.

PERSONALS

▸ **C. Richard Coslow,** assistant industrial relations advisor in the foreign trade department, Socony-Vacuum Oil Company, Inc., is being transferred to assistant general manager of the company's operations in Austria. He became general manager with retirement of **H. P. Rudinger.**

He attended Cornell University, University of Pittsburgh, and the School of Advanced International Studies, Washington, D. C. Coslow began with Socony-Vacuum in 1946 as a staff assistant in the training department, New York City division.

▸ **John H. Murrell,** an authority on petroleum valuation, will be a special lecturer for the spring semester at the University of Texas. He is a general partner in the Dallas firm of DeGolyer and MacNaughton, petroleum, geological, and engineering consultants and a member of the State Board for Registration of Professional Engineers. Murrell will deliver a series of 14 weekly lectures at the University on the appraisal of petroleum properties and the appraisal of stocks and bonds of companies owning petroleum properties.

▸ **Edward J. Nopper** has been appointed assistant chief engineer for Sun Oil Company's manufacturing department. Nopper has served as

Edward J. Nopper

Sun's chief electrical engineer for the past 14 years. He joined Susquehanna Pipe Line Company, a Sun Oil affiliate in 1932.

A graduate of the Baltimore Polytechnic Institute and the Bliss Electrical School, Tacoma Park, Maryland, Nopper worked with Allis-Chalmers Company before joining Sun. He is co-inventor of patented electrical systems and controls for the motor operated valves in Houdry fixed bed catalytic cracking units, and also devised the "brain" of these units — a 900 point cycle timer.

▸ **Joe B. Alford** of Dallas, Texas, has been appointed executive secretary of the petroleum branch of the American Institute of Mining and Metallurgical Engineers. He succeeds **William H. Strang** who resigned recently to affiliate with the American Petroleum Institute.

Since January, 1949, Alford has been editor of the *Journal of Petroleum Technology*, a monthly magazine, and also assistant secretary of the branch.

Alford attended Texas Technological College and Leland Stanford University.

▸ **Jess E. Adkins,** Dallas, has been appointed editor of the *Journal of Petroleum Technology*. He will also serve as assistant secretary of the branch. He received a BA degree in business and a BS in journalism from Southern Methodist University.

▸ **L. C. Monroe,** formerly manager of distribution for Union Oil Company of California, has been appointed manager of traffic for that company. He succeeds **J. D. (Jack) Rearden** who retired after 43 years of service.

Monroe joined Union Oil in 1921 as a rate clerk in Los Angeles, becoming manager of distribution in 1946. Rearden was employed by Union Oil in 1906 as a clerk in the traffic and marine department in San Francisco, and was appointed traffic manager in 1914.

▸ **O. E. Bransky** has been appointed chief of the petroleum branch of the Marshall Plan by the Economic Cooperation Administration. Bransky has been identified with the petroleum industry since 1910 when he joined Standard Oil Company (Indiana) as a research chemist. He retired from that company in 1948 and became an ECA consultant.

▸ **B. K. Ullmann** has joined the Societe National de Material pour la Recherche et l 'Exploitation du Petrole, purchasing agency for French operating Oil Companies, in the New York office. Ullmann, who succeeds **Andre Dubos,** will be under the supervision of **M. R. Thomas.**

All purchasing operations will be conducted from Paris with accounting and shipping operations performed by the New York office.

▸ **R. J. Lindquist** of Chicago, financial vice president and director of Standard Oil Company (Indiana), has been elected to the board of the American Security and Trust Company of Washington, D. C. Lindquist joined Standard Oil (Indiana) as financial vice president in 1945 and was elected a director in 1946.

▸ Promotion of **E. J. Jameson** to assistant manager of the material and traffic department of the Carter Oil Company has been announced.

E. J. Jameson

Jameson joined the Carter Oil Company in 1939. Prior to 1939 Jameson was employed as educational director for the First Baptist Church in Muskogee, Oklahoma. He was graduated from Oklahoma A. & M. with a B.S. degree in 1934.

▸ **William B. Harper,** well-known petroleum economist, has joined the New York staff of the American Petroleum Institute as director of research. Harper has been with the National Industrial Conference Board as petroleum economist and business analyst for the past six years. During those years he founded the Petroleum Almanac.

After majoring in economic and industrial analysis at New York University and Brooklyn College, Harper served as security analyst for the Fitch Publishing Company. Before joining the Conference Board he was industrial analyst for the Standard and Poors Corporation.

▸ **Jack A. Nelson** of Chicago, Illinois, diesel engineer with Standard Oil Company (Indiana), has been appointed general chairman for the national diesel engine meeting of the Society of Automotive Engineers, Inc., at the Hotel Knickerbocker in Chicago November 2 and 3, 1950. Nelson joined Standard Oil Company (Indiana) in 1937 as an automotive engineer in Des Moines, Iowa.

Author of "Industrial Diesel Engines" and several other papers on diesel lubrication, Nelson has done pioneer work in the use of heavy-duty type oils in large diesel engines.

▸ **J. Bennett Hill,** director of the chemical and engineering division of Sun Oil Company's research and development department, recently was appointed chairman of the Subcommittee on Aircraft Fuels, National Advisory Committee for Aeronautics.

Dallas-Fort Worth Nomads Initiate New Members

Initiation rituals for new members in the Dallas-Fort Worth Nomads have been set up with a definite thought in mind: To help the new members become acquainted in a minimum of time, according to A. J. Olson, chapter president. These new members wear lop-sided mustachios at the initiation in Fort Worth recently.

Each new member to be intiated is supplied with a trick hat or costume to make him conspicuous such as the Robin Hoods posed at right. Placards hanging on front and back carry the name of the neophyte and his company affiliation. He also has some task at the meeting so that he immediately assumes his active participation.

These budding members had smaller identification cards so as not to obscure the graceful grass skirts. (You couldn't hide those wigs.) They are N. E. Barber, Mid-Continent Cummins Export Corporation; R. H. McLemore, Welex Jet Services, Inc.; K. W. Davis, Mid-Continent Supply Company; G. G. Wilbur, International Derrick and Equipment Company.

Initiates at the right look rugged in helmets and pads. J. E. Jonsson, ad liber supreme, formally welcomes each candidate in Dallas meetings with instructions as to how (or how not) a Nomad should conduct himself at all times. Instructions are personalized by commenting on each candidate's association with the equipment industry along with his company's activities.

LAUGH WITH BARNEY

Three men and a dog were sitting very seriously around a table playing poker. The dog held a hand just as the men did, and played its cards with no indication from the other players that there was anything in the least unusual about a dog's playing poker.

As the evening wore on, the woman of the household came in. Seeing the dog playing, she said to the men: "Why that's the most amazing thing I've ever seen."

"What's so wonderful?" barked the dog. "I haven't won a hand yet."

There are two kinds of men who never amount to very much—those who cannot do what they are told and those who can do nothing else.

MacTavish and McCleary were arrested for being drunk and disorderly. During the hearing of the case the judge asked:

"Where is the other man?"

"What other man, sir?"

"The man who paid for the drinks."

Reporter: Do you think the Senator put enough fire into his speech?"

Congressman: In my opinion, the Senator didn't put enough of his speech into the fire!"

"Who was that lady I saw you outwit last night?"

He (twice nicked by the razor): Hey, barber, gimme a glass of water?

Barber: Whassa matter, hair in your mouth?

He: No; I wanna see if my neck leaks.

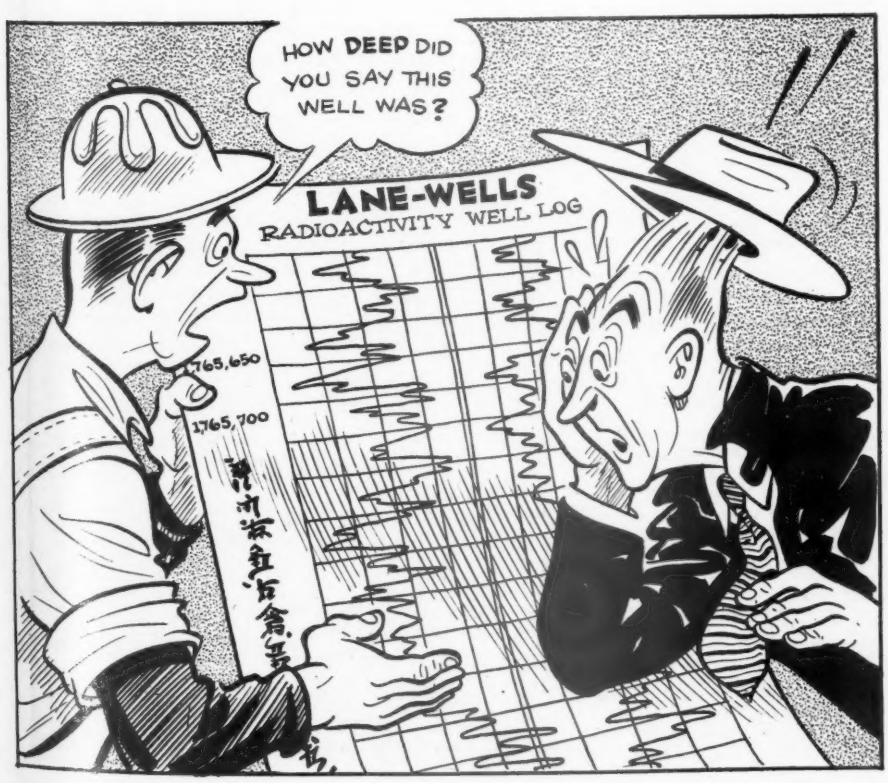
A panhandler stepped up to Henry and asked for 20c for a cup of coffee.

"But coffee is only 10c," objected Henry.

"I know," was the polite retort, "but won't you join me?"

A school teacher received this note one morning: "Please do not give my son any more home work. The question you asked about how long it would take a man to walk around the block 40 times caused me to lose a whole day's work. Then, after I had walked it, you marked the answer wrong!"

It's easy enough to be pleasant
And spend all your time being jolly,
But the man worth while
Is the man who can smile
When his wife finds a letter signed
"Dolly."



I think that I shall never see a hazard rougher than a tree—a tree o'er which my ball must fly if on the green it is to lie; a tree which stands that green to guard, and makes the shot extremely hard; a tree whose leafy arms extend to kill the mashie shot I send; a tree that stands in silence there, while angry golfers rave and swear. Niblicks were made for fools like me, who cannot ever miss a tree.

Firmness—that admirable quality in ourselves that is merely stubbornness in others.

The minister in the Highland hamlet had no more ardent admirer than old Jean. As he thundered forth denunciations of the sins of immorality, lying, drunkenness, her amens were heartfelt.

One day he turned his attention to a habit among older women of pipe-smoking.

Old Jean left the meeting, clutching her pipe firmly.

"I can't do with preachers when they stop preaching and start meddling," she said.

Irate Father: Why were you kissing my daughter in that corner last night?

Dubious Danny: Now that I've seen her in the daylight, I sort of wonder myself.

A grumpy-looking man boarded the train, arranged his coat, hat and luggage, called for a pillow, made himself comfortable, extracted a sizable sign from his brief case and propped it on his lap. Then he closed his eyes. The sign read: "I don't trust Stalin; the weather's unusually nice for January; the country is full of Reds; I hope we won't have another war; I think prices will start descending in about a year, but that we won't have another depression. Wake me up at Schenectady!"

Love-making hasn't changed in two thousand years. Greek maidens used to sit and listen to a lyre all evening, too.

A pretty young girl came to a dinner party wearing a tiny silver airplane on a chain around her neck.

It was a charming ornament and she was not only proud of it but was quite conscious of it. She found her handsome dinner partner eyeing in the direction of the silver trinket, so she smiled and asked: "Do you like my little airplane?"

"Yes," replied the gallant young man by her side, "I do, but I was mainly admiring the landing field."

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OIL AND GAS TRADE NEWS

Equipment Suppliers Meet

The board of directors, Pacific division of the Petroleum Equipment Suppliers Association held a membership meeting in Los Angeles, California preceding the general membership meeting being held this year at White Sulphur Springs, West Virginia. The district meeting was held March 9 in the Ambassador Hotel theatre and Embassy room. T. Sutter, chairman of the board, appointed Hugh Glen, Jack Pike, and Warner Parker to assist him with details.

Fluor Corporation Adds Engineering Building

As part of the Los Angeles main plant expansion program, the Fluor Corporation, Ltd., engineers, constructors, and manufacturers for the oil, gas, chemical, and allied industries has started work on a new engineering building. Details of the modern structure, which is a part of the modernizing plans at the 27-acre plant, were disclosed by J. S. Fluor, Jr., executive vice president. The two-story air-conditioned building will have 9200 sq ft of floor space, including a full basement. It will be constructed of pre-cast reinforced concrete.

Fluor personnel directly connected with construction plans include George W. Meyer, manager of lands and buildings, coordinator, and Fred Hopkins, project manager.

Production Specialties To Represent Rolo Company

Production Specialties Company of Midland, Texas, has been named engineering sales and service representatives for the Rolo Manufacturing Company of Houston, in West Texas and New Mexico. Production Specialties Company was formed early in 1949 for the purpose of providing equipment and techniques to answer special problems that arise in the production of oil and gas.

Lee Flood, owner of the Midland company, was graduated as an engineer from Leland Stanford University in 1930. Formerly an editor of The Petroleum Engineer magazine in Dallas, Flood served as chief engineer for the Goldsmith Pool Engineering Committee in Midland, prior to forming Production Specialties.

Durametallic Appoints New Representatives

New Salt Lake City representatives for the Durametallic Corporation, manufacturers of metallic packings and mechanical seals, is the Bullough Asbestos Supply Company of Salt Lake City, Utah. Ben Bullough heads this organization with Bill Seeley as sales manager and Keith Swenson and Ralph Sartori on the firing line.

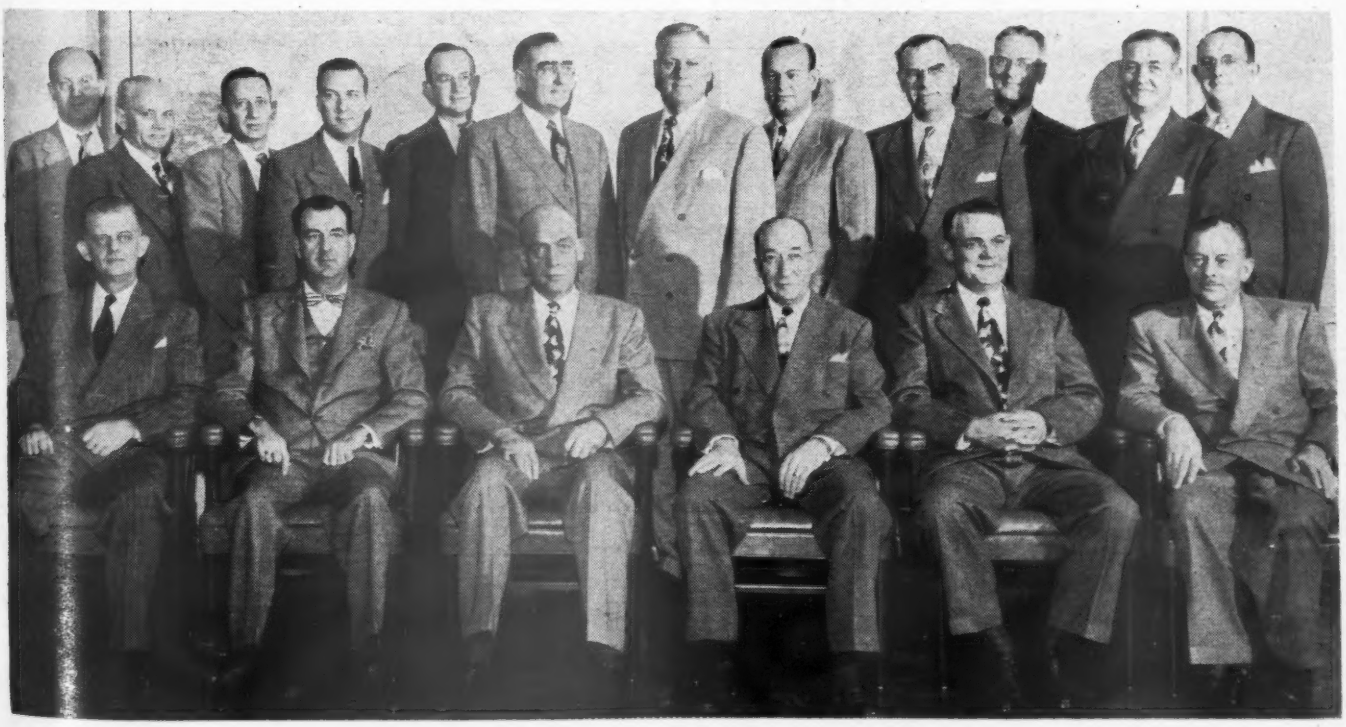
In Atlanta, Georgia, Carl Houck will represent Durametallic. Louis G. Collins has assumed representation of the Durametallic Corporation products in Milwaukee, Wisconsin, and surrounding area.

Ross Recktenwall, Jr., Gunderson-Taylor Machinery, is promoting the sale of Durametallic flexible metallic packings and Dura Seals in Denver, Colorado.

Tube Turns Moves Offices

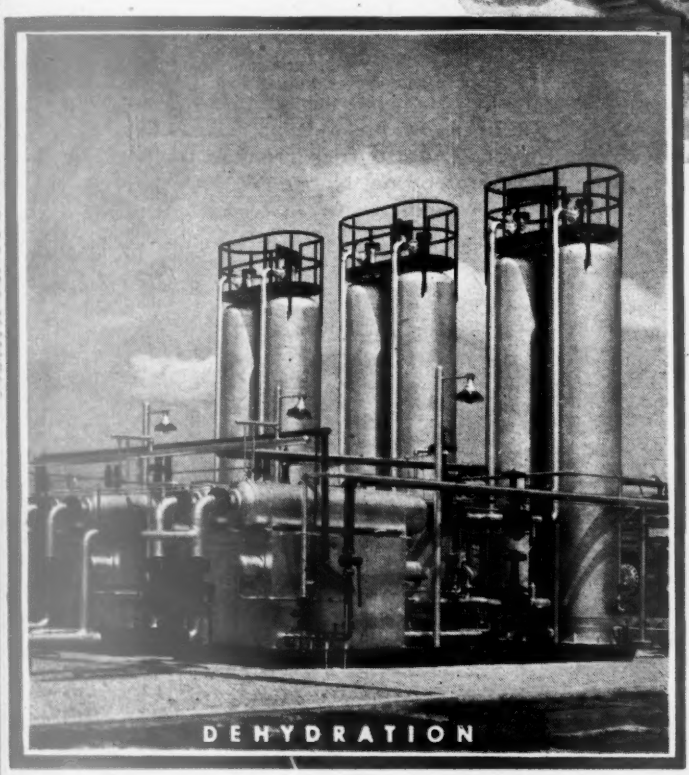
The Tulsa office of Tube Turns, Inc. has been moved from 317 South Detroit Avenue to 420 Wright Building. The telephone number, 2-9193, remains the same. Robert S. Tyler, Jr. is manager of the Tulsa office.

To exchange ideas and develop new and better methods of serving Lane-Wells customers, this group of Lane-Wells executives met early in January in Los Angeles at the managers meeting. L to R, back row: Ray Masters, E. A. Miller, L. H. Ingle, D. R. Dillehay, Val L. Forsyth, Morton T. Higgs, Jas. D. Hughes, W. S. Keim, Jr., R. A. Hancock, Frank A. Taylor, P. M. Terrill, W. A. Miller. Front row: C. F. Ludwig, R. B. Downing, D. S. Jeppson, Norman L. Dorn, John J. Neale, and J. W. McPhee.

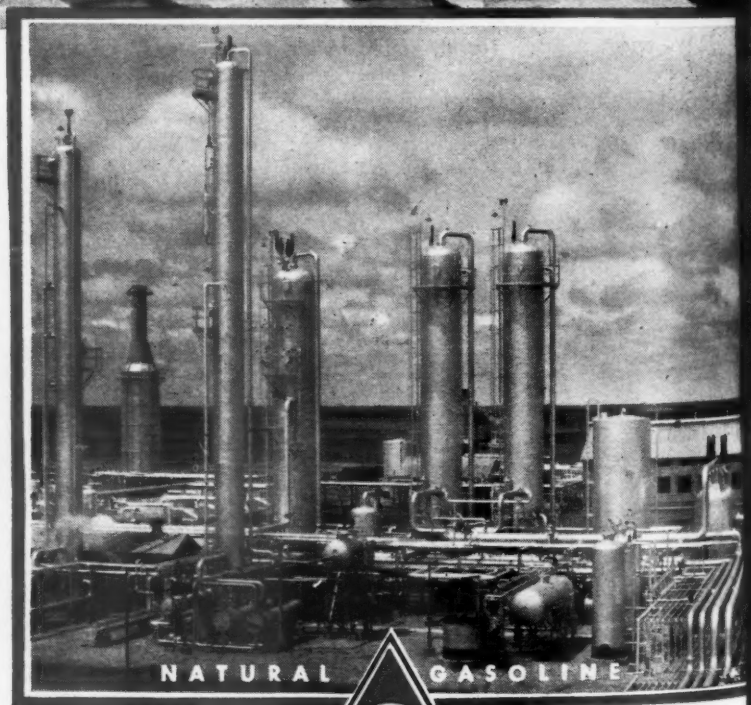


Continental

GATHERING OF OIL AND GAS



DEHYDRATION



NATURAL GASOLINE

THE CONTINENTAL SUPPLY COMPANY, General Offices: DALLAS, TEXAS

The Continental Supply Company, Limited, 216 Lancaster Building, Calgary, Alberta

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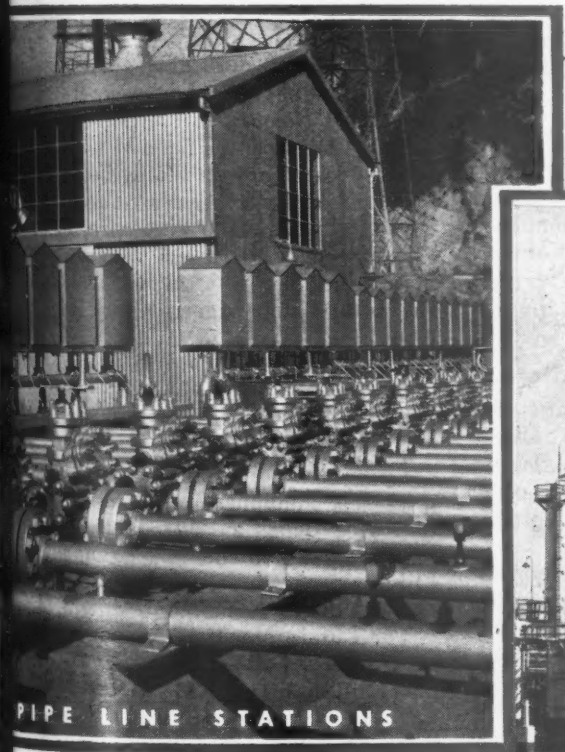
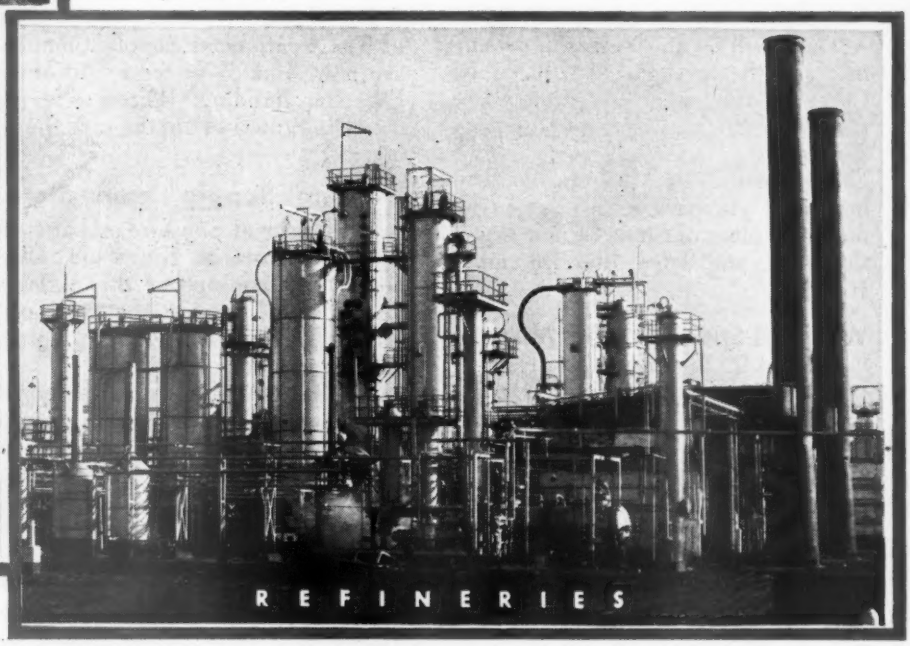


PIPE LINE STATIONS



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Appoints Florida Salesman

Black, Sivalls and Bryson, Inc., manufacturers of oil field equipment and products for the chemical, agriculture, foundry, and grain feed industries, announces the appointment of Johnson Roney II as BS&B's new Florida representative to handle safety heads and related products.

Roney is at 608 Oak Avenue, Clearwater. His more than 30 years of experience in engineering and sales were accumulated with such companies as RCA, General Electric, DuPont, and Hercules. He was formerly sales manager for the La Bour Company, Inc. The appointment was effective January 1.

Form Partnership

Robert R. Wheeler, geological consultant, and J. N. Ingraham, who will handle oil investments, have formed a new partnership. Offices for the Wheeler and Ingraham partnership are at 910 Continental Building, Dallas, Texas.

Climax Engineering Purchased

Black, Sivalls & Bryson, Inc. has purchased all of the assets of the company formerly known as Climax Engineering Company, controls division. The business will be continued under the official name of Black, Sivalls and Bryson, Inc., climax controls division.

There will be no changes in personnel, and the products distributed by Climax in the past will continue to be manufactured at Tulsa, the company announced.

Black, Sivalls and Bryson, Inc., will honor all purchase orders issued by the Tulsa plant of Climax Engineering Company, and dated after December 16, 1949.

Waddell Speaks at Ad Meet

Milford R. Waddell, vice president and director of the National Industrial Advertising Association, was the guest speaker of the January 19th meeting of the Association. Waddell, whose address was "Some New Concepts of Industrial Advertising", is director of industrial and public relations division of Black, Sivalls and Bryson, Inc., Kansas City, Missouri.

Forms Canadian Subsidiary

Taylor Forge and Pipe Works, Chicago, Illinois, has announced the formation of Taylor Forge and Pipe Works of Canada, Ltd. This new subsidiary will be located at Hamilton, Ontario, and will augment the productive capacity of the company, which now has plants at Chicago, Illinois, Carnegie, Pennsylvania and Fontana, California. The new facilities at Hamilton will permit the company to participate actively in the Canadian market for the products of its manufacture.

Taylor Forge and Pipe Works was organized in 1900 by J. Hall Taylor who is board chairman of the company. Operations at Hamilton will start in a new building now being designed to suit the intended manufacturing.

Continental Divides Divisions

Separation of its domestic and export distributor sales and service groups, in the interest of closer cooperation between factory and field, has been announced by Continental Motors. Howard T. Conrey, for many years a Continental field sales representative, has been appointed manager of the domestic distributor sales and service division, with headquarters in Muskegon, Michigan, and A. S. Bolthouse continues in the corresponding export post.

Conrey joined the company in 1946 as a sales representative, and has served in various sales and service capacities since. C. Wheeler Johnson, vice president in charge of distributor sales and service, and of advertising, has overall direction of domestic and export divisions.

Continental Supply Moves District Offices

The Houston, Texas district offices of The Continental Supply Company are now situated in Suite 540 Mellie Esperson Building. Offices were formerly in Suite 1447 in the same building.

National Supply Opens Store

The National Supply Company has opened a store at Ringwood, Oklahoma. The firm opened this outlet in an effort to provide the most convenient and expert service to the district's operators.

The Ringwood store is under the direct supervision of W. M. Jones of Oklahoma City, district manager for National Supply. R. L. Johnson, formerly manager of the company's Lindsay store has been appointed store manager.

Ralph F. Blair, formerly at the firm's Oklahoma City store, is Ringwood's field sales representative. W. D. McNamara, formerly associated with the firm's Seminole store, has been transferred to Ringwood store.

Price Sheets Available

The Babcock and Wilcox Tube Company has issued price sheets for its seamless carbon steel merchant boiler tubes for the convenience of its customers. These sheets show, in tabular form, the present day prices per hundred feet for all quantity brackets.

Oceco Moves to Chicago

The Pettibone Mulliken Corporation, a 70-year-old Chicago, Illinois concern has purchased The Johnston and Jennings Company of Cleveland, Ohio, including its Oceco division; vent valves, flame arresters, gauges, swing lines and other tank equipment. The entire finished inventory of Oceco products, including all work in process, records, etc. have been moved to the Pettibone Mulliken Corporation's 30 acre Chicago plant.

George Fox, sales manager and certain key engineering and production personnel, have been moved to Chicago. Sales representation continues practically unchanged. The company will be known as: The Johnston and Jennings Company, division of Pettibone Mulliken Corporation. The new address is 4710 West Division Street in Chicago.

National Supply Opens Store

The National Supply Company has opened a new store at Plainville, Kansas. The new outlet is northwest of Russell, Kansas, where National Supply also operates a store.

C. E. Peery, store manager of the Plainville unit, was formerly at the company's Russell Store. Another former Russell employee Leon V. George, is also located now at Plainville.

J. C. Love is field sales representative at Plainville and the entire operation is under the direct supervision of C. S. Miller, National Supply's assistant district manager at Great Bend, Kansas.

A feature of the Plainville unit is a shop for pump repair service.

Forms Canadian Company

Lufkin Foundry and Machine Company has announced the incorporation of a Canadian subsidiary to be known as Lufkin Machine Company, Ltd., with headquarters at 14321—108th Avenue, Edmonton, Alberta.

The Lufkin Machine Company, according to Walter W. Trout, president, will distribute and service all oil field equipment manufactured by the Lufkin plant, including pumping units, gas engines, and commercial reduction gears, and, in addition, will represent such manufacturers as Gaso Pump and Burner Manufacturing Company, of Tulsa.

Charles Dyer, long-time associate of Lufkin Foundry and Machine Company, has been appointed resident manager. The officials of the new company will consist of L. A. Little, president; A. E. Cudlipp, vice president; and M. L. Wilkinson, secretary-treasurer, with Charles Dyer and W. T. Crowder, Jr., assistant secretaries.

G-R Heat Exchangers

in this installation

...how many can you find?

The engineers of this natural gas plant indicated their conviction of the superiority of G-R Heat Transfer Apparatus in the most definite manner . . . by ordering 110 G-R units for their heat transfer services.

THE ROSTER OF G-R EQUIPMENT IN THE PLANT IS AS FOLLOWS:

- 40 Shell-and-Tube units for coolers, condensers and oil-to-oil exchangers
- 2 Steam-heated Reboilers
- 61 Twin G-Fin Sections for gas coolers and product coolers
- 5 Oil Chillers using propane as the chilling medium
- 1 Fin-Fan Steam Condenser
- 1 Type R Evaporator

Here, as in many other plants throughout the oil and gas industry, G-R Heat Transfer Apparatus has been selected because of the long G-R leadership in developing designs to meet the advancing needs of the industry, and the proven excellence of performance of G-R equipment.

Whatever may be *your* heat transfer requirements, be sure to consult G-R . . . pioneers in heat transfer apparatus . . . for authoritative recommendations.

THE GRISCOM-RUSSELL CO.

285 MADISON AVE., NEW YORK 17, N. Y.

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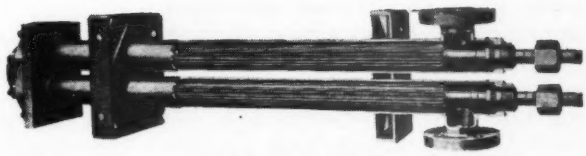
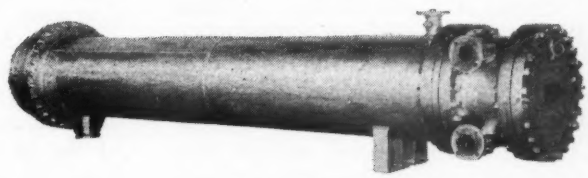


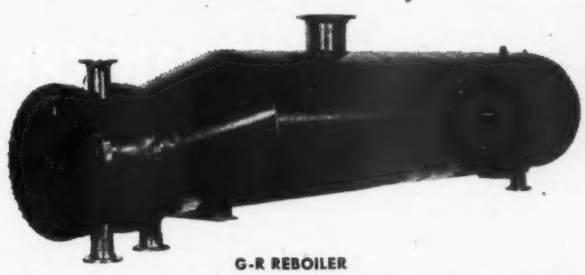
G-R TWIN G-FIN SECTION

The "universal" standard interchangeable heat transfer unit with longitudinally-finned elements. More than 40,000 installed sections.



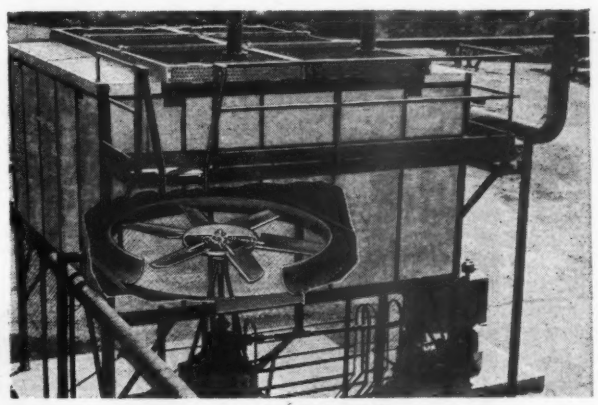
G-R TUBULAR EXCHANGER

A shell-and-tube unit with many distinctive features for efficient performance with minimum attendance and maintenance expense.



G-R REBOILER

Widely used in process industries, and available with either bare tubes or K-Fin helically finned elements.



FIN-FAN EXCHANGER

The "package-type" air-cooled exchanger developed jointly by The Griscom-Russell Co. and Fluor Corp. Ltd., and widely adaptable wherever the cooling water supply is insufficient or impure.

Publish Article on Zeolites

Although considerable information is available on the performance of organic zeolites in the sodium cycle with brine regeneration, comparatively few reports have been published on the results obtained from such zeolites in the hydrogen cycle with acid regeneration.

A paper on this subject was delivered to the Tenth Water Conference of the Engineers' Society of Western Pennsylvania at Pittsburgh on October 18, 1949, by V. J. Calise, technical director of Graver Water Conditioning Company. The paper has recently been published as an article, with tables of results obtained and charts showing the characteristics of these zeolites. Copies can be obtained by addressing Graver Water Conditioning Company, Department 135, 216 West 14th Street, New York 11, New York, and asking for Article TA-115.

Blaw-Knox Appoints Alberts

Chemical plants division of Blaw-Knox Company has announced the appointment of L. W. Alberts as manager of its recently organized synthetic fuels and chemicals department.

This department will provide technical and construction services for the building of facilities for the manufacture of synthetic chemicals and fuels from natural sources. Developments in the Fischer-Tropsch synthesis and related syntheses of alcohols, aldehydes, methane, etc., will be the basis for the work.

Fireproof Coating for Metal Developed by Eagle-Picher

Refinery and drilling rig operators know that when an accidentally-set fire gets too big and hot, steel beams may warp and twist if they are uncovered. Recently the Eagle-Picher Company of Cincinnati, Ohio has put on the market a lightweight fireproof coating for metal that will resist three hours of intense heat, preventing warping.

Porter, Jarecki Consolidated

The H. K. Porter Company, Inc., has announced the consolidation of its company with the Jarecki Manufacturing Company. Hereafter it will be known as the Jarecki Manufacturing Company division of H. K. Porter Company, Inc.

With the consolidation of the Jarecki Manufacturing Company and the H. K. Porter Company, W. Howard Pape was elected a vice president of the H. K. Porter Company, Inc. Pape will continue in charge of the oil field country distribution.

Graver Names MacDonald As Sales Representative

Graver Water Conditioning Company, manufacturer of equipment for all water conditioning processes, announces the appointment of Russell R. MacDonald Company as its sales engineering representative in the Richmond, Virginia, territory, with headquarters at Atlantic Life Building.

The MacDonald organization, headed by Russell R. MacDonald, will handle all of the Graver water-conditioning equipment, including hot and cold process water softeners, zeolite water softeners and demineralizers, deaerating heaters, chemical feeders, and filters for removal of taste, odor, oil, iron, silica, etc., from water for boiler feed, municipal water supply, chemical process, and general uses.

Offers Air Service To Polio Victims

The Weatherford Oil Tool Company has offered the services of its fleet of airplanes to the Texas Chapters of the National Foundation for Infantile Paralysis. The company announced that it would fly polio patients from anywhere in the state of Texas or surrounding states to the Gonzales Institute or any other hospital in Texas for treatment.

Specify HONAN-CRANE Oil Purification for DIESELS

In this plant Honan-Crane Purifiers are direct connected to twenty-four 1,000 HP Cooper-Bessemers; nineteen 1,000 HP Worthingtons and eleven 1,450 Rathburn Jones engines . . . a total of 68,950 HP.

Honan-Crane Purifiers are available with both single and multiple cartridge-type, quick-change refills . . . using either cellulose fiber, or fullers earth purifying media.

Proven Design Increases Safe-Use Life of Oil... Cuts Maintenance Costs

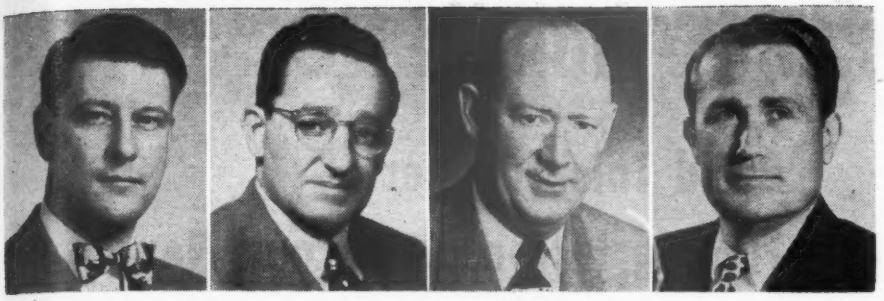
Honan-Crane Oil Purifiers are the choice of leading Diesel operators and engineers for purification of lubrication oils in Diesel Engines.

Honan-Crane's purifiers remove abrasives, acids, sludges and all other types of damaging contamination . . . give maximum protection against bearing failure . . . extend safe-use life of oil, thereby reducing the need for frequent oil changes. Design characteristics of Honan-Crane Purifiers have been tested thoroughly for many years under all kinds of operating conditions.

On-the-job performance has proved that the *best* saves you *most* in the long run. Give your diesels the finest protection you can buy . . . specify HONAN-CRANE.

For complete information (or, a Honan-Crane resident engineer will call at your request) . . . write to Honan-Crane, 573 Wabash Avenue, Lebanon, Ind.

HONAN-CRANE CORP., Lebanon, Indiana
Subsidiary of HOUDAILLE-HERSHEY CORP.



M. B. Sawyer, Jr. D. L. Mills H. E. Rowland P O. Dehlendorf

A. O. Smith Reorganizes Sales Department

The A. O. Smith Corporation has contracted for new manufacturing and supply facilities and has set up a more flexible sales organization, according to M. B. Sawyer, Jr., manager of the company's motor division. A. O. Smith has contracted with Whirl-A-Way Motors, Inc., of Tipp City, Ohio, to manufacture Smithway fractional horsepower motors to specification..

A. O. Smith has appointed D. L. Mills, president of Whirl-A-Way, as Eastern regional sales manager of the motor division, with headquarters in Dayton, Ohio. Three Eastern area sales managers report to Mills. They are Hal E. Rowland, with headquarters in Dayton; J. P. Hoffberger, New York; and R. O. Dehlendorf, Chicago, Illinois. Rowland was formerly with General Motors.

Sales in the 11 western states will be directed from the Los Angeles plant, which will also supervise sales in the southwest under area sales manager George H. Nichols, with headquarters at Houston, Texas.

Baldwin Opens Storeroom

The Baldwin Locomotive Works has announced the opening of a new diesel locomotive parts storeroom at Houston, Texas. The new storeroom is situated in the building that houses the storeroom of Westinghouse Electric Corporation at 5720 Clinton Drive. Rail shipments will be handled from covered loading platforms over the lines of the Houson Belt and Terminal Railway Company, which provides direct connection with all trunk line railroads entering Houston.

William A. McKnight, district manager for Baldwin, with offices in the Second National Bank Building, Houston, is in charge of the new storeroom.

New Company Formed For Pipe Line Protection

The Anode Engineering Company, a relatively new company, was formed in Tulsa, Oklahoma to offer gas, oil, and pipe line companies a specialized service of cathodic pipe line protection. Principal service of the company is the installation of magnesium and other types of expendable anodes for the mitigation of corrosion on pipe lines, tank bottoms, and other types of buried metal.

M. W. Franks is the field superintendent and W. Fred Stewart is the chief engineer. Franks was formerly with Unit Rig and Equipment, Hanlon-Waters, and Lee C. Moore Company. A graduate of Oklahoma A&M, Stewart is a registered petroleum engineer in Oklahoma.

Moves Instrument Division

The Rockwell Manufacturing Company has moved the main part of its instrument manufacturing facilities from Pittsburgh, Pennsylvania, to its Macnick division in Tulsa, Oklahoma. The products involved were the orifice meter, integrator, and related parts. The orifice meter will measure accurately over a wide range of pressures and volumes. The integrator is a development in measurement equipment that calculates the results from orifice meter chart records.

Bethlehem Supply Company held a sales meeting in Tulsa January 30 and 31. In addition to the local personnel, all resident managers, district managers, and production engineering representatives were in attendance. H. L. Hawkinson, Jr. from Houston and W. F. Taylor of Tulsa, who are not in the above picture, were also present.

Seated front row left to right: Fred Parks, J. C. Knoll, C. E. Medley, H. R. Klein, M. R. Griffith, E. S. Lewis, H. A. Wilson, P. H. Jezzard, Jr., R. A. Johnson, J. V. Spalding, W. T. Davis.

Second row: W. E. Stephenson, J. F. Eaton, F. R. House, V. W. Bailey, C. C. Crider, G. A. Tompson, C. R. Zimmerman, I. C. Smith, H. R. Powers, J. T. McKenna, N. G. Blankenship, W. J. Brady, R. E. Dow.

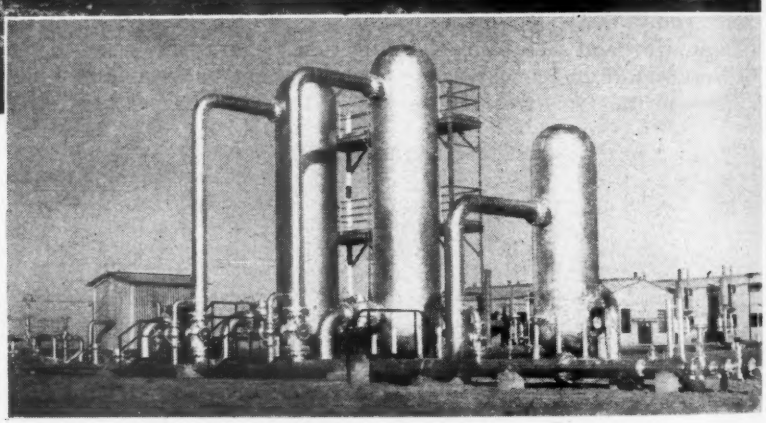
Third row standing: H. E. Davidson, R. F. Arbs, F. S. Rudrow, N. D. Lee, J. G. Floyd, D. G. Rhoads, J. K. Davis, H. S. Sutton, T. C. Graham, F. C. Batson, D. H. Geary, H. V. Harder, R. E. Garlington, Jr., Arthur Weber, Jr., C. R. McNair, Jr., G. L. Reid, Guy Brown, Jr., W. A. LaRew, R. L. Neal.

Top row: L. J. Nelson, H. A. Barnes, A. T. Padavic, G. B. Sager, C. W. Henry, D. C. Thomas, R. A. Day, Joe Chastain, O. H. Crowe, T. B. Simpson, R. W. Neal, Christian Seger, Jr., L. A. Myers, T. W. Thurmond, Jr.

"PLANTS ON PAPER" handle NO gas...

Build This Summer
For Big Increases In Load Next Fall

Progress under tough conditions—at a large compressor station designed and constructed by Stearns-Roger to handle gas from vacuum to 5500 p.s.i.g. thru ***five stages*** of compression. 12 separate engines in this line.



Up-to-the-minute dehydration plant on large main transmission gas line, operating at 900 p.s.i.g. A Stearns-Roger job from start to finish.

Call on STEARNS-ROGER'S wealth of experience in engineering, designing, manufacture, and construction. Specialists in *Compressor Stations*, and plants for *Natural Gasoline Extraction, Distillate Recovery, Gas Dehydration, Gas Sweetening, Sulfur Recovery*, and *Nitrogen Removal*.

Stearns-Roger

THE STEARNS-ROGER MFG. CO. DENVER COLORADO

HOUSTON OFFICE – CITY NATIONAL BANK BLDG. • EL PASO OFFICE – RADIO BUILDING

TRADE PERSONALS

Philip A. Norton, sales manager, Wisconsin Motor Corporation, was elected president of the Internal Combustion Engine Institute at Chicago, Illinois, recently. Norton succeeds H. W. Smith, manager of engine sales, Caterpillar Tractor Company, Peoria, Illinois.

The Internal Combustion Engine Institute is a national organization established for the advancement of this specialized industry, and its membership includes leading manufacturers of internal combustion engines of all types.

Jack P. Schwartz has been appointed as head of the new machinery sales division of United Supply and Manufacturing Company, and **Ben Reagor** as Louisiana district manager. Schwartz comes to United from Loffland Brothers Drilling Company where he was equipment engineer.

Reagor, formerly North Louisiana field representative for United, has spent many years in the oil field supply business, having started in this business 15 years ago with Superior Iron Works and Supply Company. He joined United as field representative in 1948.

Bethlehem Supply Company has announced several personnel changes in its field sales organization. **O. S. Grover,** formerly in the engineering sales department at Tulsa, Oklahoma, has been transferred and promoted to the position of chief clerk in the Dallas, Texas, sales office. **W. A. Langbein,** formerly assistant district manager at Odessa, Texas, has been transferred to the Dallas, Texas, sales office, where he will assist in the city sales contacts. **C. W. Henry,** former special representative at Pampa, Texas, has been appointed store manager and field representative at that point. **J. D. Wooten,** former field representative at the Sundown, Texas, store, has been transferred and promoted to store manager and field representative of the Kermit, Texas, store.

D. G. Rhoads has recently been employed as engineering representative and will be in the district office at Shreveport, Louisiana. **Curtis Stripling,** former assistant store manager at New Iberia, Louisiana, has been transferred and promoted to field representative at Houma. **M. R. Griffith** has recently been employed as engineering representative and will operate out of the Houston, Texas, district office. **B. L. Applegate,** a trainee in the refinery sales department, Tulsa, Oklahoma, has been promoted to the position of special representative in that department.

A. J. (Jack) Pratt has been appointed Corpus Christi, Texas, district manager for the A-1 Bit and Tool Company of Houston. He succeeds the late **R. L. Agee,** who held this position until his recent death. Pratt, who was graduated from the University of Texas in Petroleum Engineering, has acquired valuable drilling experience, serving as roughneck and driller both in this country and abroad. He began work for A-1 in 1946.

D. F. Gunby has been named manager of cementing equipment sales and service for Rector Well Equipment Company, Inc., Fort Worth, Texas.

Gunby is well known to the oil circles in the Mid-Continent and on

D. F. Gunby

the Gulf Coast where he has been engaged in production engineering, sales engineering, and more recently in consulting work. He has been associated in the past with the Phillips Petroleum Company, the Petroleum Administration For War, and the Climax Engineering Company.

W. O. Timberlake, former general manager of the Cardwell Manufacturing Company, Wichita, Kansas, has been added to the Ideco technical service staff. He will make his headquarters in Tulsa, Oklahoma.

Timberlake was graduated by Washington University with a degree in mechanical engineering. His association with Cardwell Manufacturing Company began in April of 1947.

LeRoy Mitchell

LeRoy Mitchell, a manufacturer's representative, who heads The Great Western Company of Casper, Wyoming, has recently been appointed to represent Orbit Valve Company products in the Rocky Mountain and Canadian oil fields.

Maintaining an office and warehouse in Casper, the company serves the industry with production and refining equipment manufactured by W. C. Norris Manufacturing Company, Johnson Block, and Orbit Valve Company, all of Tulsa, Oklahoma.

Melvin O. Monsler is the new sales manager of the P&H welding division of Harnischfeger Corporation, Milwaukee, Wisconsin, manufacturers of P&H arc welders and welding electrodes. Monsler has been associated with P&H for 12 years, serving for 4 years as assistant sales manager of that division and one year as welding product service engineer.

Frank Gernand, Portland, Oregon, has been appointed direct factory sales representative, covering the entire West Coast and the Territory of Alaska, for D. W. Onan and Sons, Inc.

Well known throughout the western states and thoroughly familiar with Onan products, Gernand will maintain headquarters at Portland, Oregon, but will spend the majority of his time working directly with Onan dealers and distributors in the field.

Roger W. Leason, vice president and treasurer of Emsco Derrick and Equipment Company passed away suddenly of a heart attack January 11, at his home, 5042 Van Alden Avenue, Tarzana, California. He was associated with Ernst and Ernst, public accountants, for 13 years prior to joining Emsco Derrick and Equipment Company in 1939.

Leason was president of the Los Angeles Control of the Controllers Institute of America; a member of the American Petroleum Institute; and the Jonathan Club.

▸ The Fawick Airflex Company, Inc., manufacturers of industrial clutches, recently reorganized its sales and engineering department.

In the reorganization, **John V. Eakin,** formerly Southwestern district manager, was appointed assistant sales manager, and **J. S. Walsh** was named assistant chief engineer. **J. B. Kelley,** formerly director of sales and engineering, resigned.

Frank C. Warth was appointed Southwestern district manager with offices in Fort Worth, Texas, and **C. H. Lay** was appointed Chicago district manager.

▸ **Charles E. Rice** has been appointed general manager of sales by Jessop Steel Company, Washington, Pennsylvania. He was previously manager of sales for the Pittsburgh territory, and has been associated with Jessop Steel Company in a sales capacity for seven years. Previously he had been with the Crucible Steel Company of America for 22 years.

Eugene N. Lohre, formerly assistant to the vice president in charge of sales, has been named assistant general manager of sales by Jessop Steel Company. He joined the company in August 1948.

E. H. Dau has been appointed manager of sales for the Pittsburgh territory. After 13 years with the Carnegie-Illinois Steel Corporation, Dau joined the Jessop Steel Company in 1943.

Raymond R. Huffman, formerly manager of service-sales department, has been appointed assistant to the executive vice president. He joined the company in May, 1946.

▸ **Frank Turner** and **Dale M. Thomson** have joined the sales staff of The Western Company, acidizing and perforating company with headquarters in Midland, Texas. Turner was manager of The Western Company's Odessa station when moved to the sales department and has been with Western since 1945. Before the war, Turner was a salesman with the Rector Well Equipment Company in North Texas and Oklahoma. He has worked also with the Davidson Drilling Company, Loffland Brothers Drilling Company, in the drilling department of Stanolind Oil and Gas Company.

Thomson began his career in the land department of Phillips Petroleum Company in Tulsa and later was engaged in oil well acidizing and cementing for 10 years with the Industrial Service Division of Dowell, Inc., in the Mid-Continent area.

▸ **V. P. McAnally** has been appointed as district manager of the state of Kansas and **Allen Hughes** has been appointed city salesman for the Houston office of United Supply and Manufacturing Company.

McAnally, a veteran with the oil field supply business, was with Bovaird Supply Company for 23 years before joining United.

▸ **Rodney G. Freeman, Jr.** has joined the sales division of International Derrick and Equipment Company. His office will be in the new Dresser building, Houston, Texas.

Freeman is a graduate of Mississippi State where he studied mechanical engineering. He has spent considerable time in the oil field and oil field manufacturing plants. and will work in the South Texas and Louisiana areas.

▸ **Stephen A. Sloan** was recently named manager of research and development, Peabody Engineering Corporation, New York, New York. In his new appointment he will be charged with the responsibility of not only extending the present line of Peabody equipment but also developing new products.

Sloan joined Peabody in 1943 and, previous to this promotion, was manager of the air heater department.

GRIP-TITE STEARNS— PIPE LINE ANCHOR ASSEMBLY

"The Only Positive Expanding Anchor"

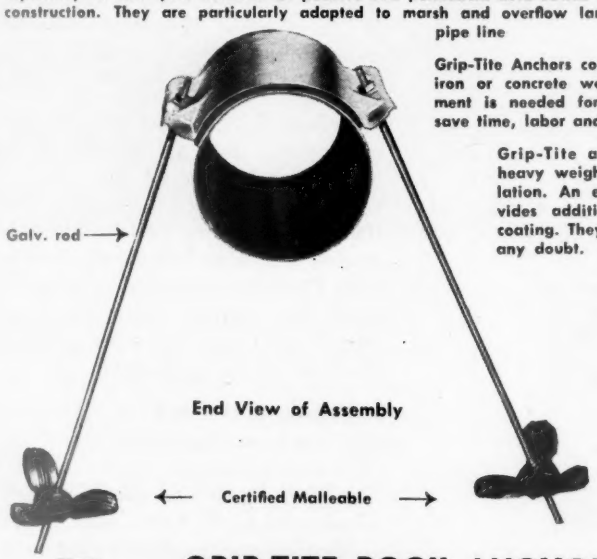
The Grip-Tite Pipe Line Anchor Assembly with Stearns Pipe Saddle was originated and designed especially to meet your demand for positive and permanent hold-downs for all kinds of pipe line construction. They are particularly adapted to marsh and overflow lands as weights for your pipe line

Grip-Tite Anchors cost only a fraction of cast iron or concrete weights. No heavy equipment is needed for their installation. They save time, labor and other handling expense.

Grip-Tite affords protection from heavy weight damage during installation. An expansion joint pad provides additional protection to pipe coating. They are field proved beyond any doubt.

Comparative cost charts are available upon request.

Write for literature

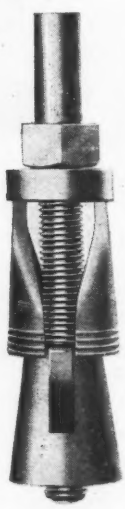


GRIP-TITE ROCK ANCHORS

Designed to meet the demand of the industry for permanent hold-downs in rock terrain for both pipe line and oil field construction. They are also adaptable as hold-downs in foundations and may also be used above ground in rock terrain in place of Grip-Tite Earth Anchors. Grip-Tite Stearns Pipe Line Anchor Assembly may be equipped with the Rock Anchor instead of Earth Anchor, for above ground pipe line construction in rock terrain.

They are made of CERTIFIED MALLEABLE and so constructed that when load is applied, expanding forces anchor wings against the walls of the hole to effect a positive grip at all times. Corrugations on the bearing surfaces of the wings prevent any slippage. The standard 2" size expands to 2⅝" and is equipped with ¾" rod; 3" size expands to 3⅝" and is equipped with 1" or 1¼" rod. Actual tests of 2" size equipped with ¾" rod show a breaking strength of 20,000 lbs.

Anchor Expanded



Ready to Install

Grip-Tite **MANUFACTURING COMPANY**

P. O. Box 45, Marshall, Texas

Export: R. S. Stokvis & Sons, Inc., 17 Battery Place, New York 4, N. Y.

Sold Through Supply Stores

how to GET MORE WELDING from your PIPE WELDERS

The exceptional accuracy and uniformity of Midwest Welding Fittings enable the welder to spend more time in welding and less time in preparation. He does not have to struggle to line up fittings and pipe . . . all pipe can be cut in advance according to drawings . . . he need never compensate for inaccuracies. Time and money savings are substantial.

The dimensional accuracy and uniformity of Midwest Welding Elbows result from a unique method of manufacture. These elbows are first made slightly oversize . . . then reheated to forging temperature and brought to final size in *compression dies*. This assures true circular cross section, uniform wall thickness and accurate radius, included arc and tangents.

Midwest Welding Fittings save you money . . . there is a distributor near you . . . it will pay you to call him.

3718

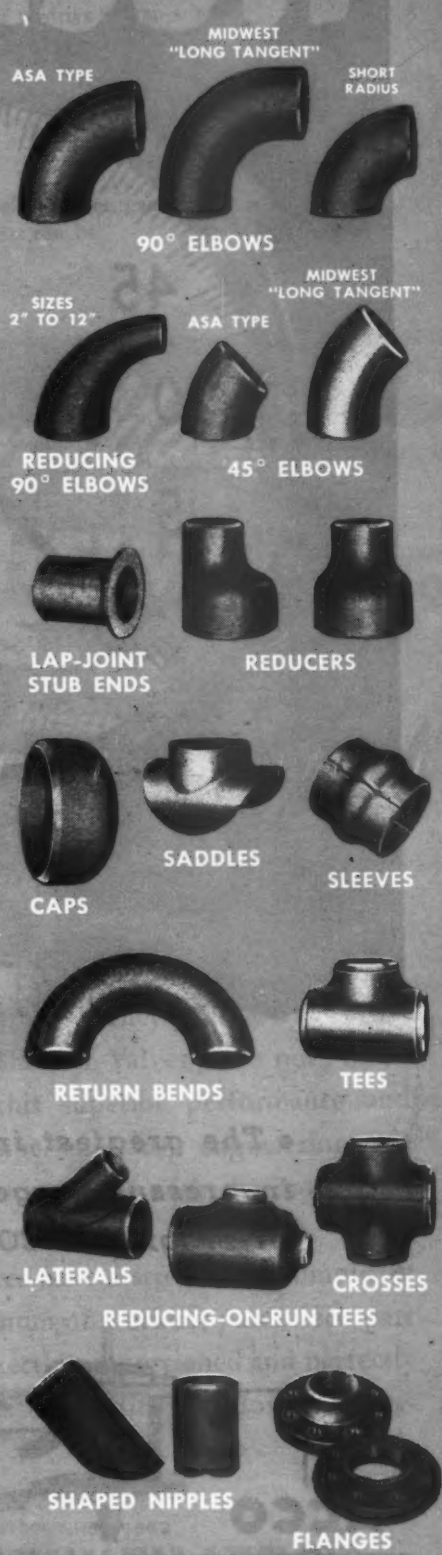
MIDWEST

PIPING & SUPPLY COMPANY, Inc

MAIN OFFICES: 1450 SOUTH SECOND ST., ST. LOUIS, MO.

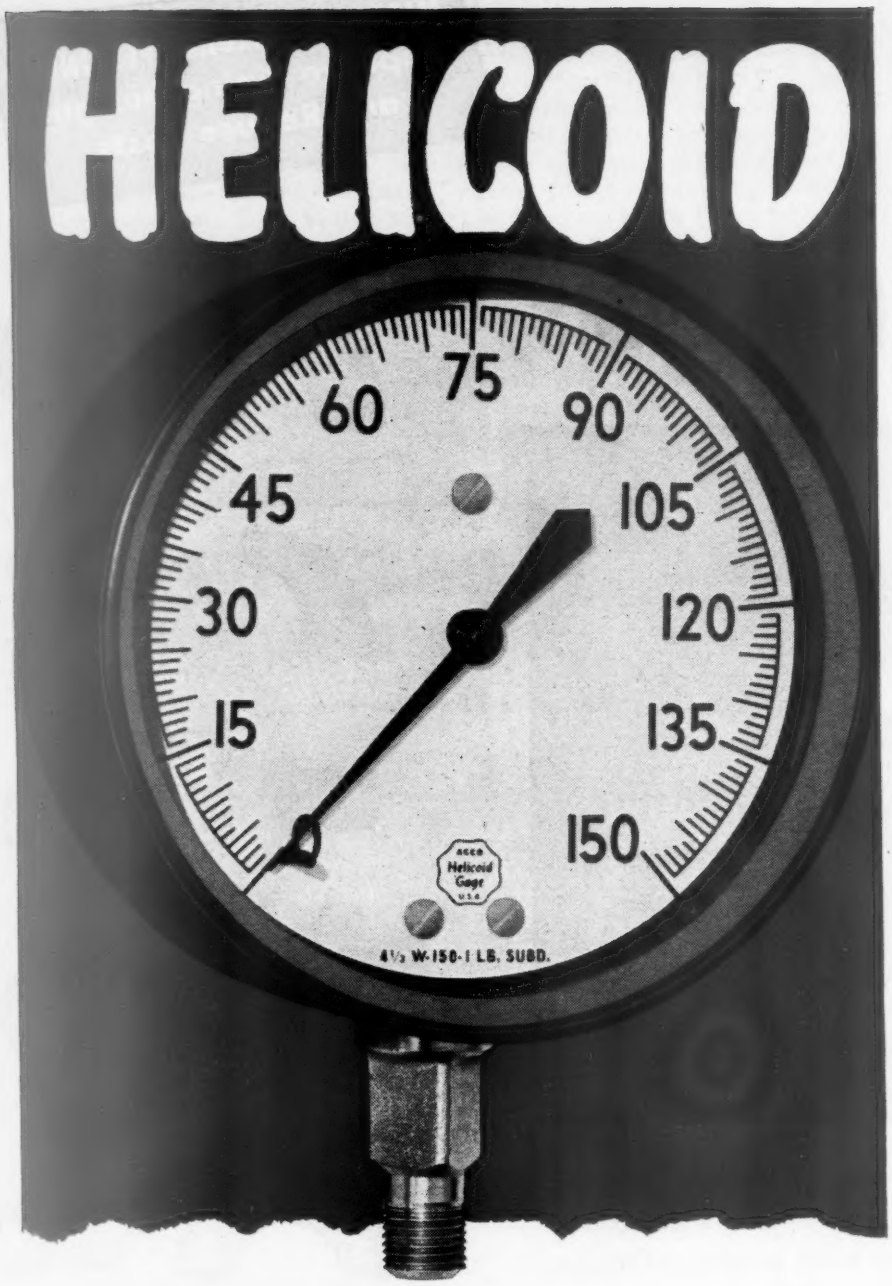
PLANTS: ST. LOUIS, PASSAIC (N.J.) and LOS ANGELES

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs

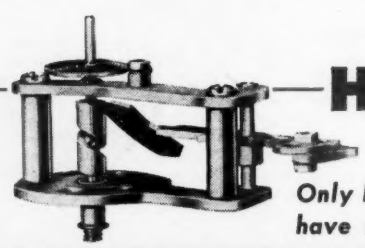


SALES OFFICES

New York (7), 30 Church St. • Chicago (3), 79 West Monroe St. • Los Angeles (33), 520 Anderson St. • Houston (2), 229 Shell Bldg. • Tulsa (3), 533 Mayo Bldg. • South Boston (27), 426 First St. • Distributors in Principal Cities.



• *The greatest improvement in pressure gages in 100 years. Write for HELICOID GAGE CATALOG.*



HELICOID

ACCO

Only Helicoid Pressure Gages have the Helicoid Movement

HELICOID GAGE DIVISION
AMERICAN CHAIN & CABLE COMPANY, INC.
Bridgeport 2, Connecticut

TRADE MARK

▸ **Selden A. Stone** was recently appointed sales representative, well drill sales, by Bucyrus-Erie Company, South Milwaukee, Wisconsin. Attached to the Evansville, Indiana, office he will maintain his headquarters at 111 Eighth Street, Williamstown, West Virginia.

Stone began in the oil field equipment business with the Parkersburg Rig and Reel Company in 1934. Later, he worked with the Continental Supply Company as a field service representative. After this, he spent about two years with the Franklin Supply Company and more than seven years in the drill sales organization of Bucyrus-Erie Company, which he now rejoins.

▸ **A. (Archie) L. Ethriedge** was appointed field representative in Oklahoma for Hercules Tool Company, Tulsa, Oklahoma. Formerly, he was associated with Axelson Manufacturing Company as a field salesman with headquarters in Shreveport, Louisiana. Ethriedge has had varied experiences in the oil fields of Oklahoma, Texas, Arkansas, and Louisiana.

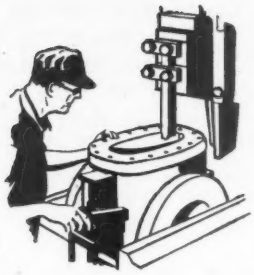
▸ **H. L. Hurley,** Rockwell Manufacturing Company, will handle all major oil and engineering company accounts in the Houston district, replacing **J. W. Northcutt,** who was recently appointed Atlanta district sales manager.

Hurley has been with the company since 1943 as sales and service representative for valves and gas equipment in Southwest Texas. Prior to making his present connections, he served as pipe superintendent for the Arthur G. McKee Company on the construction of the Great Southern Refinery at Corpus Christi, Texas.

▸ **F. L. Radican** has been appointed district salesman for The Altens Foundry and Machine Works, Inc., Lancaster, Ohio, manufacturers of Alten pumping units and other oil field production equipment. Formerly with The Rollans Elliot Company of Tulsa, Oklahoma, Radican will supervise the sales and servicing of Alten equipment in the states of Kansas and Oklahoma with headquarters in Tulsa.

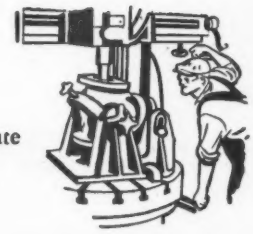
▸ **Don W. Cunningham,** recently became sales manager of the Empire Machinery Company, Ltd., with headquarters in Odessa, Texas. Simultaneously, **K. W. Richie,** former Empire sales manager, assumed a position in specialized sales with the company, to cover the entire West Texas and Eastern New Mexico area.

Cunningham has wide experience in oil field equipment sales, having been associated with the Bovaird Supply Company for the past 14 years.



A DISTINCTIVE FEATURE IN DISC GUIDING

Body guides are machined down to precision tolerances, assuring a perfect guide for the disc and creating a positive center line on which all subsequent machining operations are based.



BODY PRECISION MACHINED TO INSURE PERFECT FIT OF SEAT RINGS

This operation makes inserting the seat rings in a Lunkenheimer gate valve simply a matter of screwing them into position. Parts can be replaced without any machine work or special fitting.

Fig. 1430
Iron Body Gate Valve

Fig. 1430 and complete line of I.B.B.M. and All Iron Gate Valves are described in Circular 564. Mailed upon request.

Precision Made LUNKENHEIMER VALVES....

assure perfect-fitting, interchangeable parts . . . longer valve life . . . easier, lower-cost maintenance!

THE smooth working efficiency and low maintenance cost of Lunkenheimer Valves were not "made in a day." Behind this superior performance and economy lies long experience, top engineering and metallurgical facilities together with the most modern manufacturing equipment.

Lunkenheimer Valves have a streamlined simplicity of design . . . a minimum of working parts, each part of extra strength, correctly proportioned and perfectly balanced. This assures longer life with lower maintenance expense.

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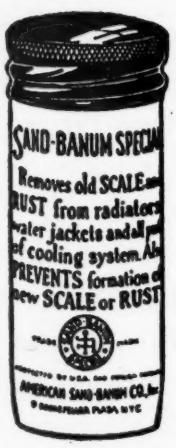
SAND-BANUM SPECIAL
(In Tablet Form)

For ALL Radiator Cooling Systems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Removes old SCALE and RUST from radiators, water jackets and all parts of cooling system. Also PREVENTS formation of new SCALE or RUST
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Comes ready to use and fully effective regardless of water or operating conditions; more power from less fuel. Send for literature on either or both.

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AMERICAN SAND-BANUM CO.
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▸ **J. Murray Walker,** export sales engineer with Lane-Wells Company, is making an extensive trip through

Murray Walker

most of the South American countries and Mexico. During his two months tour, Walker will spend considerable time with the oil industry personnel of each country acquainting them with the services and products offered by Lane-Wells.

Walker joined Lane-Wells in 1937. He has served in both the operations and sales departments of the company. He spent three years in Canada as manager of the Lane-Wells Canadian branch.

▸ **J. V. Doll** has joined Mack-International Motor Truck Corporation as vice president, fleet sales, and as special assistant to H. W. Dodge, executive vice president. For the past 20 years Doll has been associated with The Texas Company as manager of its national sales division.

Doll has been a director in the National Association of Motor Bus Opertors for a number of years. He will make his headquarters in Mack's home office, Empire State Building, New York City.

▸ **L. H. Ingle** has been named assistant controller of Lane-Wells Company. Other appointments are **Robert L. Walsh,** chief accountant succeeding to Ingle's former position; and **Walter H. Barinoff,** chief cost and methods accountant.

▸ The appointment of **A. M. Boehm** as Eastern manager, engine division has been announced by Worthington Pump and Machinery Corporation. Boehm will handle sales negotiations for gas and oil pipe lines equipment and oil and gas engines for all services, and will continue to make the Corporation's New York district office his headquarters.

Boehm has served Worthington for 25 years as an engine sales specialist assigned to various district offices throughout the country. He succeeds **W. L. Russell** who has been assigned to handle Canadian sales for the John Inglis Company, Worthington's Canadian associate.

▸ **A. O. Wells** has been named district manager for Patterson-Ballagh, division of Byron Jackson Company, West Texas, with headquarters in Odessa. As assistants to Wells for the West Texas area will be **Bob Shira, Gene Mitchell,** and **Rhoal Lyles.**

▸ **Walter D. Myers, Jr.** has been appointed to succeed Douglas Via as sales manager of the industrial insulation department of the Eagle-Picher Sales Company. Myers has been with The Eagle-Picher Company for five years. He was formerly a sales representative for the Pittsburgh area, and more recently, was in charge of industrial insulation sales in the New York market.

Before his service with Eagle-Picher, Myers spent 10 years as superintendent of the Corhart Manufacturing Company, a unit of Corning Glass Company, manufacturers of refractories.

▸ **John B. Coulter, Jr.,** recently joined The American Iron and Machine Works Company as a salesman in West Texas. Coulter will maintain his residence at Midland, Texas, and work through the district sales office at Odessa, Texas.

He is a graduate of George Washington University with a degree in mechanical engineering, and was most recently connected with the Drill Collar Service Company of Midland, Texas.

▸ **Fred R. Geib,** technical representative in the Midwestern area, of the Dowicide division, The Dow Chemical Company, has been assigned similar duties on a national basis. He will work closely with the chemical sales force in the company's sales offices throughout the United States, and will be concerned with developmental problems involving bactericides and fungicides.

▸ **Ed M. Disler,** after an absence of 18 months, has again become associated with the oil well plunger pump division of Pacific Pumps, Inc., Huntington Park, California. He will be the plunger pump, northern division manager, with headquarters at 150 East Norris Road, Oildale, California.

H. (Barney) Barnard, president of Goodall Rubber Company of Texas, and **R. J. Goehrig,** vice president and general manager of the Goodall-Whitehead Companies, Trenton, New Jersey, took a two-weeks trip to Mexico recently.

During his trip to the Southwest, Goehrig also made inspection trips to various oil fields in this area.

J. L. Mathieu, who was for many years with the Schlumberger Well Surveying Corporation in Houston, Texas, is now manager of that company's Paris organization. Immediately before taking over his duties in France in 1948 he spent two years with Schlumberger in South America.

Mathieu is presently taking an active part in new petroleum exploration in the effort to find oil in Western Europe and Africa.

He writes that the picture is bright. Over 500 wells will be drilled this year in Germany. Holland already has a good oil field and is testing a gas structure in the Permian. Italy has many good structures in the Po River valley, three of which are already proved. France has made three discoveries in the past six months, one in Alsace, one near the Spanish border, and one in Tunisia. Shell and Gulf are entering into Tunisia operations and Standard (New Jersey) will soon become active in France. Austria will come into the oil picture as soon as the treaty is signed.

Clarence G. Davenport, associated with The McCarty Company of Los Angeles, California, since 1930, and **Willard H. Wilde,** manager of McCarty's San Francisco office since 1939, have been named vice presidents of the organization. Davenport, a graduate of Harvard College, has been identified with all phases of the agency's operation, and his new executive function will place him in charge of research and the development of client plans and campaigns.

Wilde, a graduate of the University of California, began with The McCarty Company in San Francisco in 1939 as an account executive, becoming manager three years later.

E. R. Gilmore has been appointed chief engineer of Rockwell Manufacturing Company's Macnick division in Tulsa, Oklahoma. This division manufactures fluid measurement instruments, chart clocks, and parking meters.

Gilmore has had a long experience in research and development of equipment for the measurement and control of fluids. He is a graduate of Rensselaer Polytechnic Institute, 1920.

R. L. Forsythe and **A. H. Curran, Jr.,** have received promotions in the Schlumberger Well Surveying Corporation. Forsythe, formerly district manager for Schlumberger Well Surveying Corporation at Long Beach, California, has been transferred to the company's Canadian office in Calgary, and has been promoted to assistant area manager. He will be one of two Americans representing Schlumberger in Canada.

Curran, senior field engineer for the Long Beach district, has been promoted to Long Beach district manager, replacing Forsythe in that post. He joined Schlumberger in 1945.

Joe F. Rolette, former purchasing agent and office manager for the chemical division of Houston Oilfield Material Company, Houston, Texas, who was retired in November, 1949, has reentered the mud chemical business. Rolette has been named Gulf Coast sales manager for the chemical division of Mud Products, Inc. His territory will be the Gulf Coast area.

Rolette will be assisted by **Ellis B. Ford,** salesman, and **Mrs. Bernie Dyer** who was associated with him in his former connection. Prior to his association with Homco, Rolette was in the accounting department of the Gulf Oil Corporation, Tulsa.

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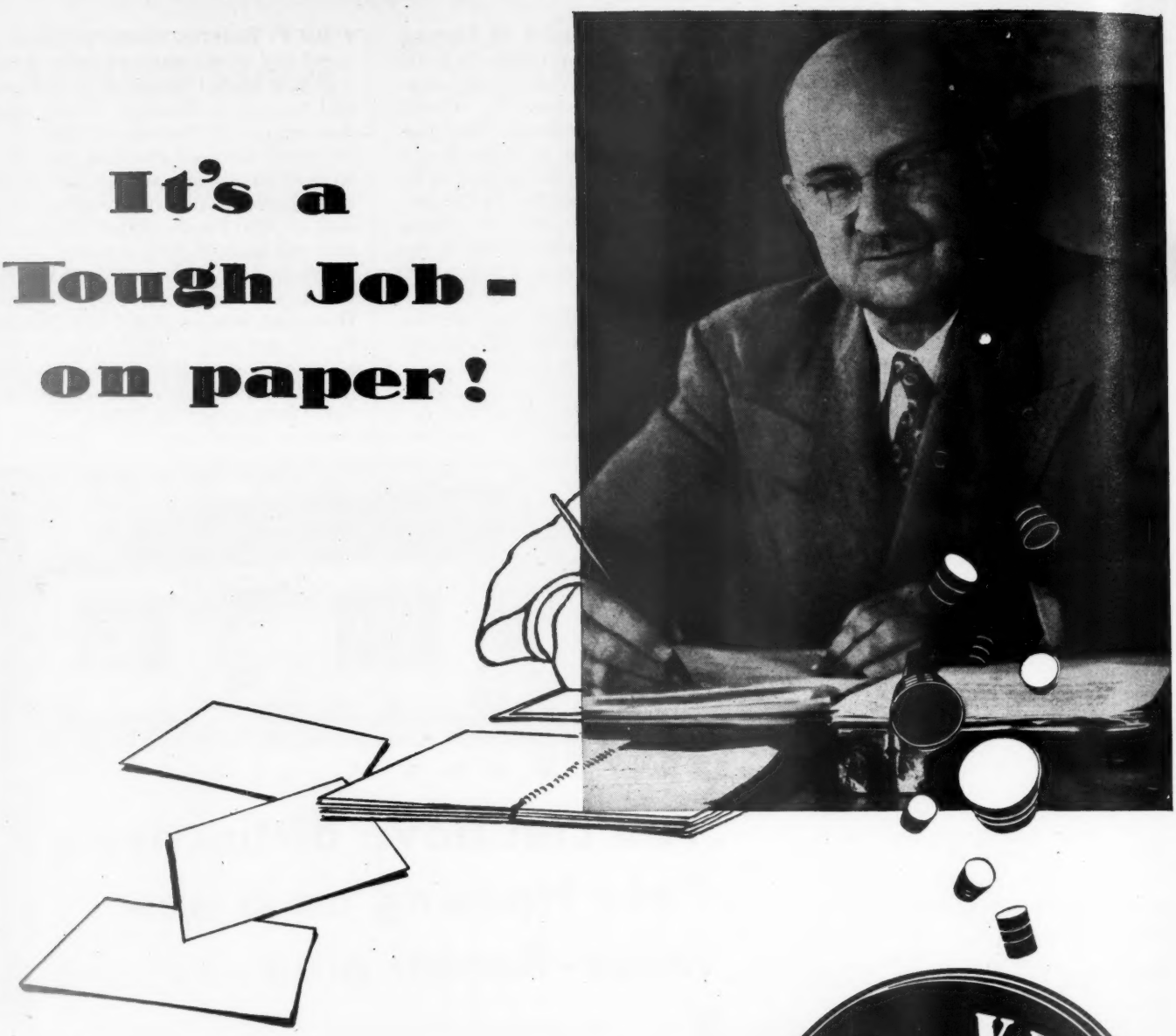

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If your treating has been an all-hours headache, better switch to the blue Visco barrels . . . no knockout drops in them, but efficient, economical emulsion-breaker performance around the clock, year after year. Call Houston, CAPITOL 7300, collect, for Visco action, *now!*

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A REGULAR FEATURE
appearing in
THE Petroleum Engineer
Irwin-Keasler Building
Dallas 1, Texas

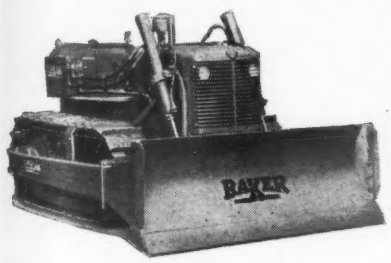
(1) Ultra Violet Lamp

An adapter that allows the new Mineralight Model SL ultra-violet lamp to operate on 110-volt d-c has recently been announced by Ultra-Violet Products, Inc., 5205 Santa Monica Boulevard, Los Angeles, California. The news is of particular interest to drilling contractors who use ultra-violet light to study core samples and for other analytical work. Now, by using the new adapter the long wave Mineralight can be more effectively used around drilling rigs, where 110-volt d-c is available. With this adapter the SL Mineralights can now be used on 110-volt a-c, 110-volt d-c, and on battery.

Information on the use of ultra-violet light in the petroleum industry is also available on request from the manufacturer.

(2) Bulldozers, Gradebuilders

A complete new line of Baker bulldozers and gradebuilders for Allis-Chalmers HD-5 tractors has been



placed in production by Baker Manufacturing Company, Springfield, Illinois. These are hydraulic controlled through twin hydraulic cylinders mounted at the front of the engine frame.

Both the bulldozer and the gradebuilder are mounted close to the radiator so as to maintain tractor balance and stability and utilize the full power of the HD-5 tractor. Conversion from the bulldozer to the angling gradebuilder can be accomplished with a minimum investment. Both bulldozer and gradebuilder are available for standard and also wide gauge Allis-Chalmers HD-5 tractors.

(3) Texrope Belt

The availability of a super-7 Texrope belt with a 40 per cent higher rating than the standard belt has been announced by Allis-Chalmers' Texrope drive department, Milwaukee, Wisconsin.

In offering this new addition to the company's V-belt line, the manufacturer points out that the high-capacity belt maintains the same stretch characteristics as a standard belt and has the same safety factor margin. It originally was offered for installations where space was limited and a standard drive could not be used. Recently, it has been finding more general use in industry as the price of a complete drive utilizing the high-capacity belt is less than for a standard drive.

(4) Pipe Line Felts

GAMA Industries, Inc., 79 Pine Street, New York City, has announced a new line of asbestos pipe line felts for use in conjunction with coatings as an inorganic, non-rotting wrapping or shield. Made to meet American Waterworks Association specifications, it is composed of pure asbestos fiber, felted by the latest methods and machinery into a basic, uniform, dry felt with minimum ingredients other than asbestos.

Distributor is Middle West Coating and Supply, Daniel Building, Tulsa.

Get Full Details of March, 1950, Listing—Check and Mail Coupon to

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P. O. Box 1589, Dallas, Texas

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NAME ..... TITLE .....

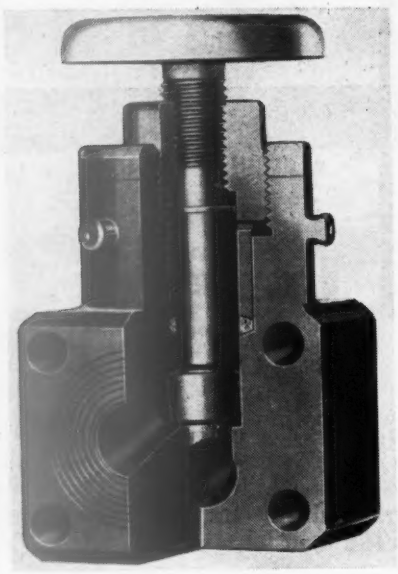
COMPANY NAME .....

STREET ADDRESS .....

CITY ..... ZONE NO. ..... STATE .....

(5) Globe Valve

A newly designed Karbate brand impervious graphite globe valve is announced by National Carbon Division.



Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, New York. The valve, in 1 in. and 2 in. sizes, is designed for shut-off and throttling service with corrosive fluids free from abrasive solids. Except for the Teflon packing all valve parts in contact with the fluid are Karbate impervious graphite, thus preventing corrosion and contamination, and practically eliminating replacement and maintenance expenses, the maker has announced.

The tapered disc valve seat assures accurate and close control of fluid flow, and is self-reseating. The valve is light and small, has short face to face dimensions and is self-lubricating. Sturdy and compact construction ensure long life, trouble free operation, and ease of installation.

A copy of Catalog Section M-8803A may be obtained by writing National Carbon Division, Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N. Y.

(6) Relief Valve

The Kinzbach Tool Company, P. O. Box 277, Houston, Texas, states that its Model 112 safety relief valve provides automatic, non-chatter snap open—snap shut action. It embodies many features in design and construction providing for safer, more efficient pump or pressure relief and greater flexibility in operations than has ever been experienced in the field, the manufacturer has stated. Today's trend of operating mud pumps near maximum rated loads demands a positive means of instantaneous pressure relief at maximum volume. The Kinzbach valve accomplishes both of these results by means of a detention wedge and sleeve plus controlled thrust restraining springs.

The valve may be used for any mud pump relief service, including compounding operations. It is made in the 2 in. size only, for working pressures from 750 to 2500 psi. Detailed information concerning dimensions, weights, and prices will be furnished upon request. Bulletin 11250.

(7) Stainless Steel

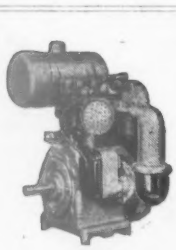
Armco Steel Corporation, Middletown, Ohio has developed a new grade of precipitation-hardening stainless steel of special interest to the chemical processing and allied industries. Known as Armco 17-7 PH Stainless Steel, the new alloy has a corrosion resistance closely approaching that of 18-8 stainless and a strength and hardness equal to those of high carbon spring steels. In addition, it can be hardened by a low temperature heat treatment.

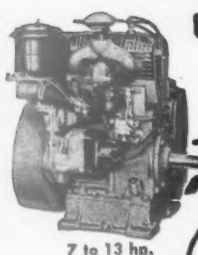
Soft temper sheets, plate and strip can be severely formed and, having an elongation of 20-40 per cent can be satisfactorily drawn. Weld efficiencies after hardening average better than 90 per cent.

(8) Power Pipe Machines

Nine new cars for sales representatives of the Toledo Pipe Threading Machine Company, 1445 Summit

Street, Toledo, Ohio, now carry the company's No. 999 2-in. power pipe machine in the luggage compartment for demonstration purposes. The pipe machines are mounted on a track in this compartment, so they can be moved forward or backward as desired. The machines will operate from a lamp socket, to demonstrate their ability to thread 2-in. pipe in 22 seconds, or cut 2-in. pipe in 10 sec.


3 to 9 hp.


7 to 13 hp.

15 to 30 hp.

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Every Wisconsin Engine from the smallest to the largest runs on self-cleaning, thrust-absorbing Timken Tapered Roller Bearings at *both ends* of the crankshaft, permitting direct drive from the extended crankshaft. Every Wisconsin Engine provides maximum freedom from cooling troubles, from sub-zero to 140° F. Every Wisconsin Engine is equipped with a high tension, rotary type OUTSIDE Magneto, with Impulse Coupling, for fast starting and dependable ignition. All good reasons why *your equipment* should be powered by these good engines.

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Elliott Company
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The Fisher Governor Company
Flint Seel Corporation
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The Hilliard Corporation
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Industrial Scientific, Inc.
Infilco, Inc.
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Naylor Pipe Company
Nordstrom Valve Company
Wm. W. Nugent & Co., Inc.
The Oil and Gas Journal
Oil Well Supply Company
O. L. Olsen Company
Orbit Valve Company
Pacific Pumps, Inc.
Paramount Supply Company
Parkersburg Rig & Reel Co.
Peerless Manufacturing Co.
Perco Div.-Phillips Petroleum Co.
Perry Equipment Corporation
Petro-Chem Development Co.
The Petroleum Engineer
Petroleum Engineering, Inc.
Petroleum Processing
Petroleum Refiner
Pittsburgh Equitable Meter Co.
Podbielniak, Inc.
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Process Engineers, Inc.
Process Equipment Co.
Refinery Engineering Co.
Refinery Maintenance Co.
The Refinery Supply Co.
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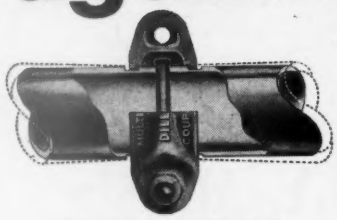
E. W. Saybolt and Co.
A. O. Smith Corporation
Standard Pipeprotection, Inc.
N. C. Stearns Company
Stearns-Roger Mfg. Co.
Superior Manufacturing Co.
Taylor Forge and Pipe Works
Taylor Instrument Companies
Tellepsen Construction Co.
Tube Turns, Inc.
Union Steam Pump Sales Co.
Vinson Supply Company
Henry Vogt Company
Walco Engineering and Construction Co.
Walworth Company
Westcott and Greis, Inc.
Western Supply Company
Woobank Machinery Company
World Petroleum
Worthington Pump and Machinery Corp.
Wyatt Metal and Boiler Works
Young Sales Corporation
John Zink Burner Company

back again..



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COUPLINGS

A grooved-type coupling with a two-part self-aligning housing. Synthetic Multi-seal gasket gives great flexibility without leakage —pressure or vacuum. Available in sizes from 2" to 20".

Hold that line with Dillon Couplings

THE DILLON CO.
TULSA 5, OKLAHOMA

NORRIS
TURNBUCKLES

FORGED STEEL
CONSTRUCTION

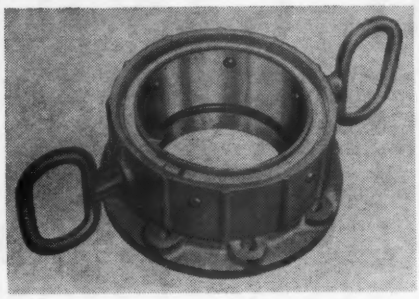
The sizes available vary from ½" to 2" with bodies for take-up of 12", 18", 24" and 36", with Stub, Hook, Eye, Pull-rod or Clevis ends.

W. C. NORRIS,
Manufacturer, Inc.
Tulsa, Oklahoma

BRANCHES — Houston, Kilgore, Odessa, Texas; Salem, Ill.; Casper, Wyo.
EXPORT—30 Rockefeller Plaza, New York City

(9) Disconnect Coupling

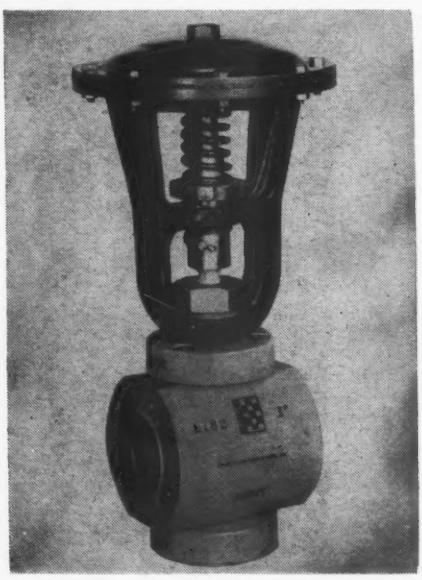
A quick disconnect coupling in a 6-in. pipe size for heavy duty applications is a new development of Roylyn,



Inc., 718 W. Wilson Avenue, Glendale, California. This new coupling, known as the 1700 Series, is designed to meet rigid requirements of heavy industry for a large coupling that is fast connecting and fast feeding, is light in weight with compact proportions, and is easily operated without tools, the manufacturer has stated. It has a dimension between flanges of only 7 in. and a weight of only 17½ lb. The coupling is rated at 150 psi.

(10) Ceramic Valve

Emmett Machine and Manufacturing, Inc., 2249-55 14th Street, Akron 14, Ohio, has announced the avail-



ability of a new Merit valve, designed especially for applications involving highly corrosive conditions as well as extreme temperatures. The valve incorporates a body made of a newly developed Merit ceramic and is suitable for continuous 300 psi operation at temperatures up to 2000 F to control the flow of highly corrosive gases and concentrated or diluted chemicals, with the exception of hydrofluoric acid and hot alkali concentrate.

Merit ceramic valve bodies are machined from a solid slug of the new ceramic prior to final firing.

BETTER PIPE TOOLS

"ARMSTRONG BROS." Pipe Dies and Chasers are machined from special alloy steel, are heat treated and oil tempered. Cutting teeth are "backed-off" with ground points—cut faster, cut easier, cut smooth, tight-fitting threads. They come in "Solid," "Adjustable" and "Receding" types to fit all standard make stocks and threaders. Standardize on "ARMSTRONG BROS." Dies and Chasers for better thread cutting.

STOCKED BY LEADING TOOL DISTRIBUTORS
Write for Catalog.

ARMSTRONG BROS. TOOL CO.
5231 West Armstrong Avenue
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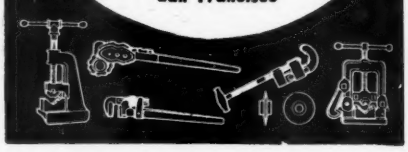
New York
San Francisco



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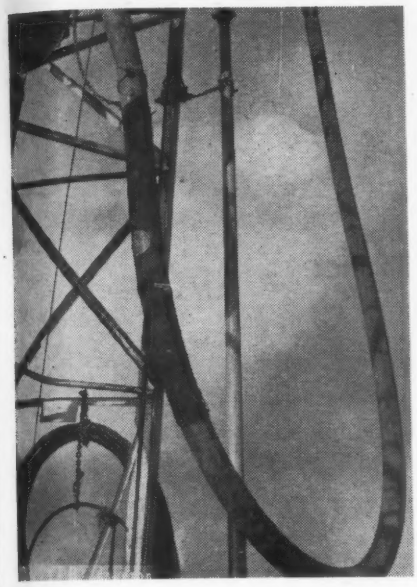
(11) Rotary Hose Protector

A rubber protector designed to be laced onto rotary hose at the point where the hose bumps or rubs against



girths and tong lines has been announced by Goodall Rubber Company, 1606 Maury, Houston, Texas. The new protector, which will be marketed under the trade name of Rubber-Hide, is made of reinforced 2-ply automobile thread stock rubber and is designed as protection for rotary hose against cuts and bruises.

Rubber-Hide rotary hose protectors are manufactured in lengths of 6 ft to fit 2½ in. and 3 in. hose. It is also available, the manufacturer said, in rolls of 60 ft.

(12) Chart Pen

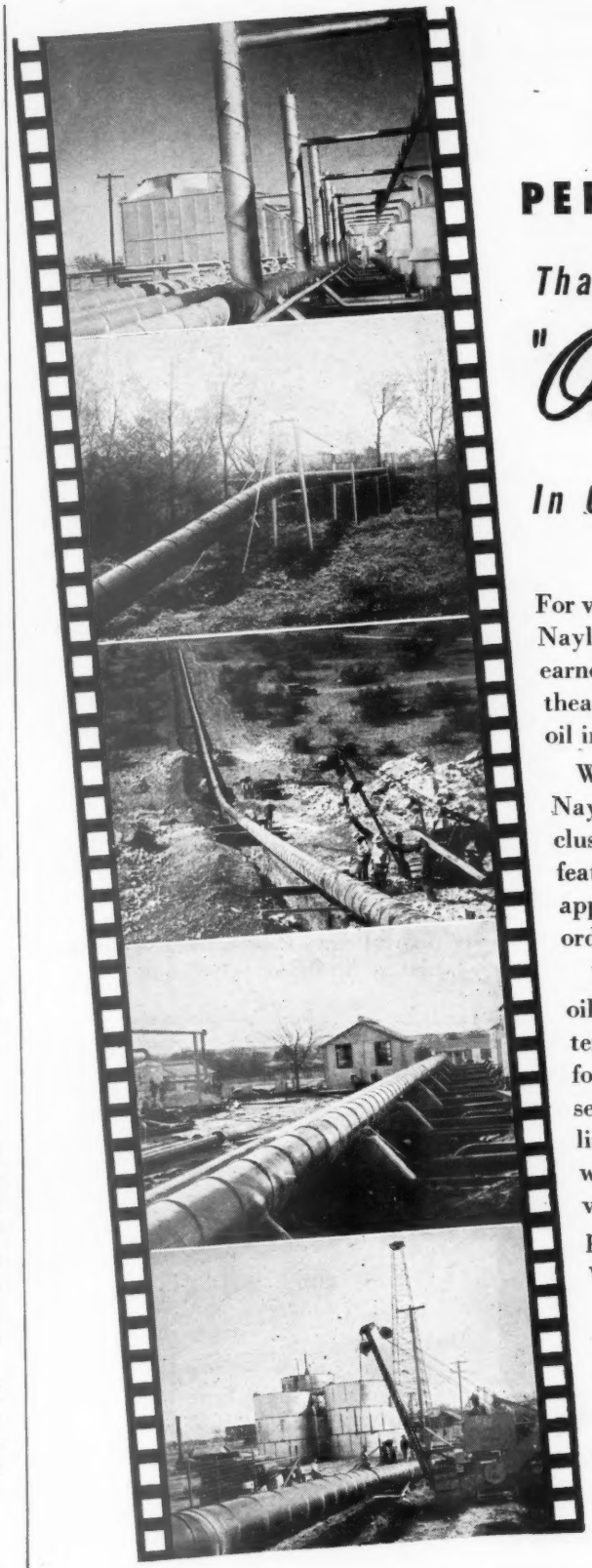
The American Recording Chart Company, 3113 East Eleventh, Los Angeles, California, announces the availability of a new automatic chart pen that will write for several months without servicing. The pen makes a clear, sharp record without smear, and has had years of field experience before offering to the trade.

Working on the capillary principle and using a closed system, the new pen utilizes an ink reservoir in the form of a bottle. A small flexible tube leads from the bottle to the pen.

(13) Check Valve

For any installation where durability with silent operation is highly desirable, the Williams-Hager flanged silent check valve is ideally suited, according to its manufacturers, Williams Gauge Company, 1620-22-24 Pennsylvania Avenue, Pittsburgh, Pa.

The Williams-Hager valve has a free floating valve disc that operates effectively and efficiently, and can be easily installed between flanges and removed for inspection.



PERFORMANCE

That Rates An "Oscar"

In Oil Field Service

For versatility of performance, Naylor light-weight pipe has earned top billing in many theatres of operation in the oil industry.

While light in weight, Naylor pipe is built with exclusive strength and safety features that permit broad application not possible with ordinary light-weight pipe.

Whether it's pipe lines for oil and gas-gathering systems, vacuum lines, piping for natural gas processing service or lines for handling sludge, water, etc.—it will pay you to take advantage of the extra utility provided by Naylor light-weight pipe.

Sizes from 4″ to 30″ in diameter and thicknesses from 14 to 8 gauge. Ask our distributors for Catalog No. 44 or write direct.

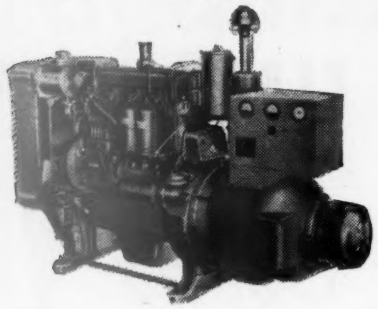
NAYLOR PIPE COMPANY
1240 East 92nd Street
Chicago 19, Illinois
New York Office:
350 Madison Avenue, New York 17, N. Y.

Naylor Pipe

Mid-Continent Supply Company
Ft. Worth, Texas and Branches
Exclusive distributors in
Mid-Continent and Gulf Coast Areas

(14) Diesel-Driven Plants

Five new models of diesel-driven electric generating plants, equipped with automatic voltage regulators and



ranging from 12½ to 55 kw have been added to the line of diesel generating equipment manufactured by D. W. Onan & Sons, Inc., 83 Roylston Avenue, Minneapolis, Minnesota.

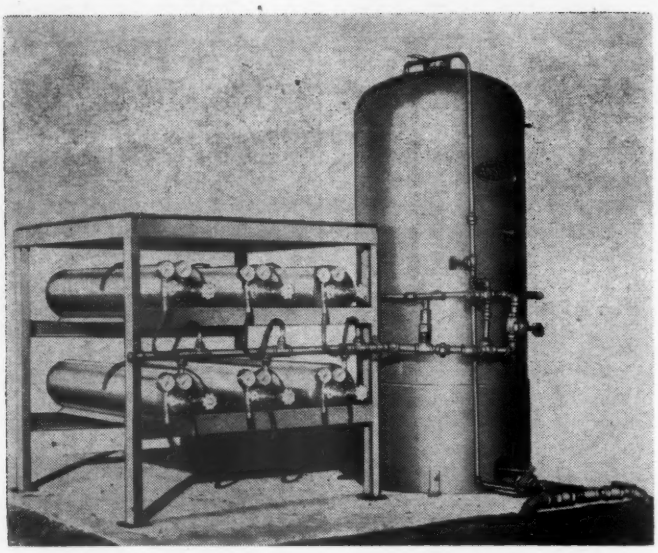
Powered by International Harvester low-speed engines, these new units combine the advantages of all-weather gasoline-engine starting with the dependability and economy of full diesel operation. The engine is cranked by a 12-volt starting system similar to any conventional gasoline engine.

(15) Dial Indicators

Announcement has been made by Taylor Instrument Companies, Rochester 1, New York, of the development

of a new concentric or full-circle dial indicator for transmitting, receiving, and controlling instruments.

This new indicator has a unique dial construction that makes instrument mechanism easily accessible for inspection or adjustment by simple rotation of the dial. Large pointer with 270 deg sweep, together with white numerals on a black background stand out effectively so that they can be read from 50 to 100 ft. The instrument may be used with only low pressure unit or mercury manometer actuation for differential or absolute pressure applications.



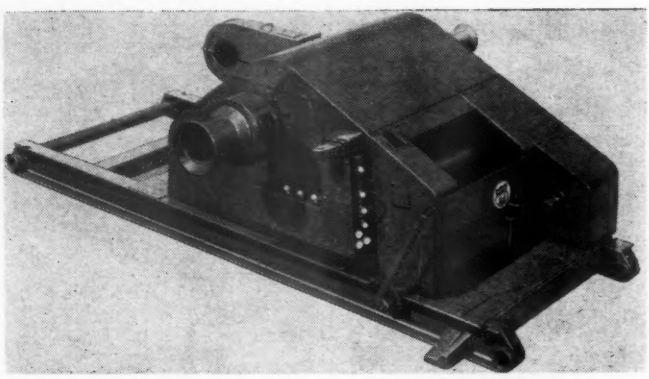
Ansul Chemical's new stationary fire fighting unit.

(16) Fire-Fighting Unit

Ansul Chemical Company, Marinette, Wisconsin, has introduced its large stationary fire fighting units, making a bid for new markets in the field of dry chemical fire protection.

These units are being built in 500-lb, 1000-lb, and 2000-lb capacities. They are designed to protect wide areas where a minimum of manpower is available—such as gasoline bulk plants, gasoline storage areas, refineries, railroad yards, petroleum and natural gas fields, large chemical plants, liquefied petroleum gas tank farms, and other major public utility hazards.

Rate of flow of dry chemical is 450 lb per minute. Recoil, a problem with this high rate of discharge, has been minimized by a specially designed nozzle. Effective range is about 35 ft. The 500-lb unit is equipped with a 365 cu ft nitrogen cylinder. The 1000-lb model is pressurized by two of these cylinders, the 2000-lb unit by four. Number of hose houses and piping outlets are determined by each customer's needs. Hose may be obtained in 50, 100, and 150 ft lengths.



Ideal Type T-16 rig developed by National Supply.

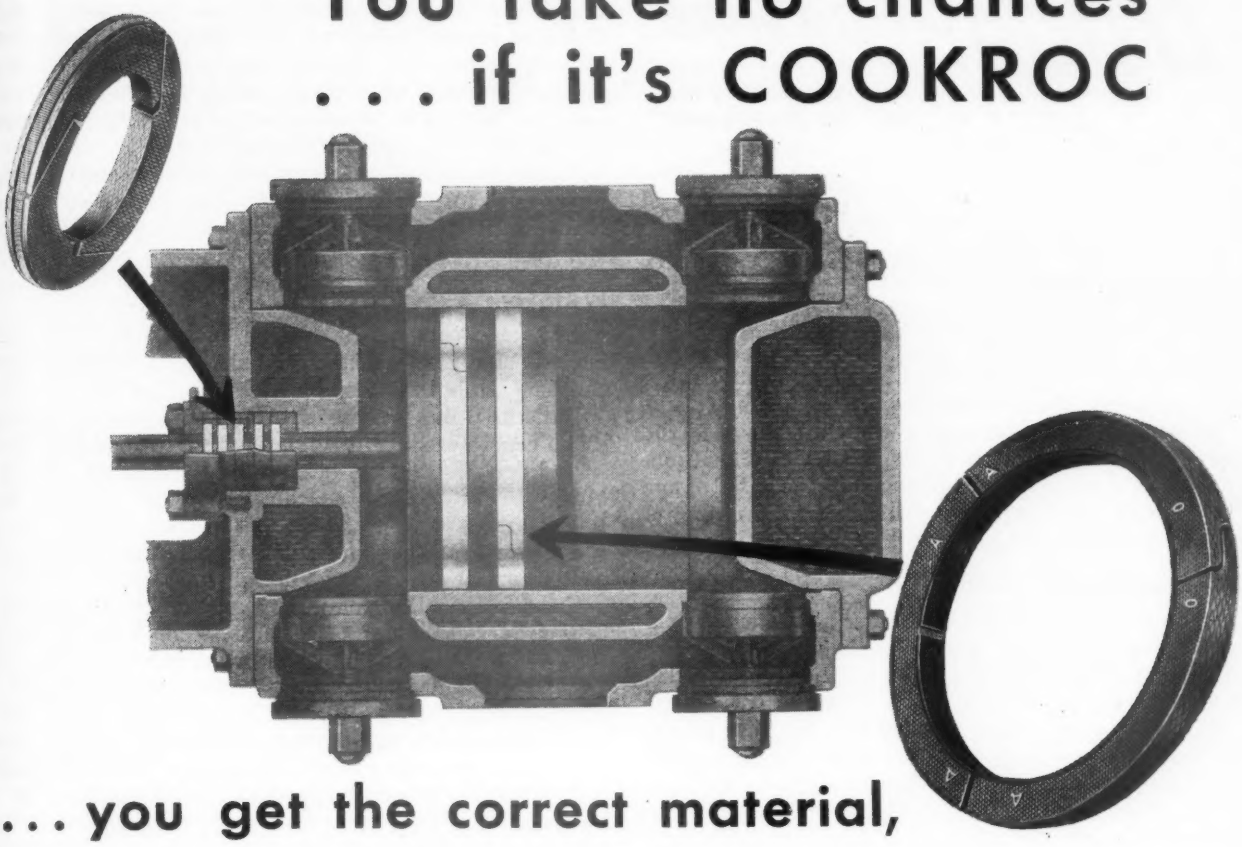
(17) Drilling Rig

Newly designed for shallow drilling and workover jobs, The National Supply Company, Box 899A, Toledo, Ohio, announces the Ideal Type T-16 consolidated rig. The new rig is normally rated at 160-hp for drilling 3000 ft with 4½-in. drill pipe and 3750 ft with 3½-in. drill pipe. For workover it is rated 7500 ft for hoisting service with 2½-in. tubing.

The T-16 rig was designed for maximum compactness and portability while retaining all of the ruggedness and durability of larger Ideal drilling rigs, the manufacturer stated. Overall width can be reduced easily to 8 ft by removing quickly detachable parts—two catheads, foot throttle pedal, and spinning line pulley bracket. The rig is mounted on "H" beam section skids 19 ft long overall. Overall height is 5 ft 10¼ in. This rig is readily adaptable to trailer mounting, thus providing further portability. The basic rig is a single engine unit without pump drive. The Ideal C-150 pump is a well matched unit for use with the Ideal T-16 rig.

Complete specifications, performance curves, shaft speed diagrams, and dimensional drawings are available from The National Supply Company.

You take no chances . . . if it's COOKROC



. . . you get the correct material, precision manufacture and results

Selecting the most suitable ring material for a particular gas condition will always be a big problem for compressor operators. The point is, there is no single foolproof formula for every condition encountered.

Because of this, Cook has developed a wide range of ferrous, non-ferrous and non-metallic materials from which to select.

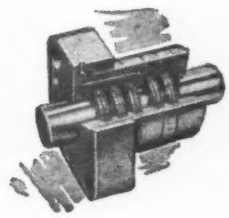
Take COOKROC. This laminated Bakelite base material is compounded especially for compressors handling gases carrying a high H_2S concentration or gases laden with hydro-carbon vapors. It comes in several forms: Standard, Graphitized and Hi-Temp. Standard size rings, stocked at Cook's plant in Louisville and its agents' Mid-Continent and California warehouses, are subject to immediate shipment.

For full information contact the Cook office nearest you.

C. Lee Cook Mfg. Co., Incorporated, Louisville, Kentucky. Branch offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco and Tulsa.

COOK

ROD PACKINGS



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trade literature

PUBLICATIONS LISTED ARE SENT FREE UPON REQUEST

(18) Pumping Units

A 16-page bulletin, No. 336, covering its line of national pumping units with Type B cranks, and showing construction features, engineering drawings and specifications, has just been issued by The National Supply Company, Toledo, Ohio. Bulletin No. 336 supersedes Bulletin No. 334, and presents detailed descriptions with tabulated dimensions and consolidated specifications of the D-9, D-11, D-13, and D-15 types of pumping units, covering the entire range for medium to heavy load requirements.

(19) Consolidated Titrilog

Consolidated Engineering Corporation, Pasadena, California, has just released a four-page bulletin on the new Consolidated Titrilog. This new bulletin describes the Titrilog application for the continuous recording of trace quantities of sulfur compounds. A schematic diagram of the Titrilog cell and amplifier helps to illustrate the section devoted to instrument operation. The measurement and control of sulfur content of natural gas is one of the important applications discussed.

(20) Ric-Wil Data Books

Two new technical data books have just been published by The Ric-Wil Company, Union Commerce Building, Cleveland, Ohio.

The Ric-Wil insulated piping system catalog—Section 480-4-in illustrates and describes the manufacture, construction, and installation of various types of Ric-Wil insulated piping. Technical data on piping systems and available Ric-Wil Services are also included in this new general catalog.

Insulated piping system technical data—Section 480-5-in. contains full illustrated technical data and specifications on all phases of insulated piping, its structure, properties, and installation procedures. Both publications are 8½ x 11 in. format and are available without charge.

(21) Liquid Bromine

A new brochure, "Methods and Materials for Handling Liquid Bromine", has been published by The Dow Chemical Company. This brochure covers safety precautions, methods and materials for handling, handling and use from glass bottles, lead-lined drums, and tank cars.

This booklet can be obtained from the pharmaceutical sales department, Dow Chemical, Midland, Michigan.

(22) Gasoline Survey

The Du Pont Company's petroleum chemicals division has completed a report on the second of its series of nationwide gasoline surveys for distribution to refineries, oil company research organizations and marketing divisions, and engine manufacturers.

This 20-page report, as was the first one issued last October, was prepared by the division as a marketing information service. It gives motor and research octane numbers and tetraethyl lead content for gasoline retailed in 35 cities in the United States and two in Canada.

(23) Casing Head

A new four-page bulletin, No. 360, describing the National Type D casing head, has just been issued by The National Supply Company, Box 899, Toledo, Ohio. This bulletin describes the Type D casing head as a simple unit designed to seal off a single string of casing in wells of medium depths and pressures where an independent tubing head is used to support the tubing.

Drawings showing construction details, and a table of dimensions for sizes from 7 x 4½ to 13⅜ x 8⅝ and rated loads of from 75,000 to 144,000 lb, are included in Bulletin No. 360.

(24) Five Catalogs

Five new catalogs have been published by Condenser Service and Engineering Company, Inc., Seaboard Trust Building, Hoboken, New Jersey.

Bulletin G-491 carries data and pictures on automatic steam generators, manufactured by Edge Moor Iron Works, Inc., Edge Moor, Delaware. It lists features of the Edge Moor generators and specifications for the Edge Moor generators.

The various types of condensers manufactured by Condenser Service are discussed in Bulletin 441-C.

Centrifugal and piston pumps, manufactured in the Condenser Service plant in Scranton, Pennsylvania, are discussed in the bulletin published by the pump division.

Lube oil and jacket water coolers are thoroughly described in the bulletin titled "Coolers Type 'AL'." To aid in the description, the company has added graphs, charts, tables, and pictures to help the purchaser in buying coolers.

Another of Conseco's products is the "Steam Jet Air Ejectors," discussed in the bulletin bearing that title. It also carries a discussion on the principal operation of the ejector, classification, inter-after condensers, steam jets for special services, and air ejector accessories.

(25) Jacketed Valves

Aloyce Steel Products Company, Linden, New Jersey, has published a 4-page folder of its corrosion resistant jacketed valves. Technical Bulletin No. 3 contains illustrated material describing these jacketed valves, giving many design features. It gives dimensions of the Aloyce gate valve, globe valve, and check valve.

(26) Water Tube Boiler

Henry Vogt Machine Company, Inc., Louisville 10, Kentucky, has published an 18-page bulletin covering the Vogt Class VL water tube boiler. The bulletin carries detailed drawings of companies where the Vogt tube boiler has been installed, along with principal data on each. It also illustrates the manufacture of these boilers, showing pictures of actual work being done on them.

(27) Hexavalent Chromium Compounds

Mutual Chemical Company of America has available for distribution a new pamphlet entitled "Properties of Technically Important Hexavalent Chromium Compounds". This booklet presents many new data on the following chromium compounds: Sodium dichromate, potassium dichromate, ammonium dichromate, sodium chromate, potassium chromate and chromium trioxide (chromic acid). For copies of this pamphlet, Serial No. 56, write to the company at 270 Madison Avenue, New York 16, New York.

(28) Hardsurfacing Rods and Electrodes

A new Selector and Comparison Chart of Hardfacing Rods and Electrodes has been released by the American Manganese Steel Division of American Brake Shoe Company. Copies are now available at American Brake Shoe Company, 230 Park Avenue, New York 17, New York.

(29) Screw Casing

An illustrated booklet has been released by Kobe, Incorporated, 3040 E. Slauson, Huntington Park, California, showing the manner in which this company torch-cuts slots in screen casing.

Beneficial effects of the process are also demonstrated in a series of pertinent discussions: Low distortion in torch-cut as compared with mill cut slots, under bending stresses, is clearly demonstrated photographically; microphotos reveal extremely low sand erosion in the heat treated areas immediately surrounding the slots; and the smoother faces of the torch-cut slots are shown to result in considerably less slot plugging.

(30) Vacuum, Pressure Testing

A new 4-page bulletin, titled *Veeco Mass Spectrometer Leak Detector*, has just been issued by Vacuum-Electronic Engineering Company, 316 37th Street, Brooklyn 32, N. Y.

Contents describes typical applications, wherever a vacuum, fixed pressure, or special atmosphere must be maintained for extended periods of time; principle of operation, features, and pertinent data pertaining to vacuum testing and pressure testing with explanatory illustrations. Write for Bulletin LD-78.

(31) Truck-mounted Cranes

Link-Belt Speeder Corporation has just published Catalog No. 2322, which contains applications, construction details, customer benefits, and specifications of the new HC-51 truck mounted shovel-crane with speed-o-matic hydraulic controls.

Paramount features of the HC-51 are fully hydraulic Speed-o-Matic controls, front drum reversing mechanism for power control load lowering (particularly advantageous for steel erection) and a heavy duty carrier specifically designed for truck-crane operation.

Catalog No. 2322 containing full details and specifications will be sent upon request by addressing Link-Belt Speeder Corporation, Cedar Rapids, Iowa.

(32) Telemetering Equipment

A 20-page, illustrated bulletin, GEA-5233, which describes the newest General Electric telemetering equipment for electric power distribution and industrial applications, has been released by General Electric Company. The bulletin gives detailed information on the frequency type, torque-balance-type, and photoelectric-type telemeters manufactured by G.E. Bulletins are available at the General Electric Company, Schenectady 5, New York.

(33) Rotary Pumps

The new De Laval-IMO pump catalog, published by De Laval Steam Turbine Company, 853 Nottingham Way, Trenton, New Jersey, is now available. This catalog shows cut-away drawings of the six different types of De Laval-IMO rotary pumps, along with a brief description of each. The IMO pump is designed to handle residual and distillate fuel oils, crude oils, all grades of lubricating oils, hydraulic oils, viscous fluids, and liquids of similar characteristics. It is particularly well suited to oil burner, pressure lubrication and hydraulic pressure services. Capacities range from 0.5 to 1000 gpm for pressures to 500 psi and capacities to 150 gpm for pressures to 1500 psi.

(34) Single Bail Tubing Elevator

A bulletin covering single bail tubing elevators, medium weight type "D" "MWD" side door and medium weight side door—is available through Byron Jackson Company, P. O. Box 2017, Terminal Annex, Los Angeles, California. Complete information on design, parts list, and general information on the BJ tubing elevators is included in the bulletin.

(35) Centrifugal Pumps

A revised instruction booklet on the installation and operation of centrifugal pumps in corrosive service has been issued by The Duriron Company, Inc. While dealing specifically with Durcopumps, the information in the 12 varnished, smudge proof pages is applicable to all centrifugal pumps. Complete information can be had by writing The Duriron Company, Inc., 17 E. 42nd Street, New York, New York.

(36) Steam Generators

The Foster Wheeler Corporation, 165 Broadway, New York 6, New York has published a new 12-page booklet on its package steam generators. The bulletin is fully illustrated with drawings, pictures, and charts. A series of drawings show the firing arrangements for coal-oil-gas package steam generators.

(37) Drill Collars

Replaceable end drill collars are being introduced to the petroleum industry by The National Supply Company, in an illustrated 28-page monograph. In it, experience to date with conventional drill collars and the various attempts to solve the problems in their use are summarized, thus showing why the replaceable end was developed and what is accomplished with it.

The booklet contains a short catalog section, which tells how to specify the new Ideal replaceable end drill collars. It includes selection charts with which the best taper joint and most symmetrical semi-permanent connections can be determined readily. Sixteen sizes and styles of taper joint drill collar connections from 2⅜ to 6⅝ in. are tabulated with dimensions. The new monograph is available from The National Supply Company, P. O. Box 899, Toledo, Ohio.

COMPACT *Series "K" Roper Pumps*

EASY TO INSTALL AND APPLY ON A WIDE RANGE OF JOBS

Yes, you can save space and reduce power costs with Roper Series "K" Pumps. They are very compact in design, yet sturdy enough to handle a wide range of jobs . . . pressure lubrication, hydraulic service, fuel supply, or transfer work pumping clean liquids at capacities up to 50 g.p.m.

They are self-lubricated by the liquid pumped . . . handle total suction lifts up to 25 feet . . . come equipped with mechanical seal or packed box . . . with or without relief valve.

Series "K" pumps are available in ¾ to 50 g.p.m. sizes, pressures to 150 p.s.i.

ROPER Rotary Pumps

SEE OUR CATALOG IN SWEET'S

Write for latest bulletin

GEO. D. ROPER CORP.
723 Blackhawk Park Avenue
ROCKFORD, ILLINOIS

(38) Reference Chart

The Cooper Alloy Foundry Company, Hillside, New Jersey, announces the publication of its 1950 reference chart. Prepared by Norman S. Mott, chief chemist and metallurgist, this six-page folder contains a comprehensive analysis of stainless, corrosion, and heat resistant alloy castings.

It contains in detail, alloy types, The Cooper Alloy type numbers, as well as comparative designations of the Alloy Castings Institute, AISI, SAE, ASTM, and others.

(39) Flow Pump

The Aldrich Pump Company, Allentown, Pennsylvania has just released a 6-page data sheet giving full information on its new 5 in. stroke triplex direct flow pump. Information presented includes: Construction and design, specifications, dimension drawings, illustrations, selection chart and table, and drive specifications.

(40) Diesel Electric Plants

Electricity at your service for any purpose anywhere is the theme of the new 1950 electric plant catalog of D. W. Onan and Sons Inc., Minneapolis, Minnesota.

This 8-page, 2-color booklet covers the complete line of Onan gasoline-driven electric plants, ranging from 260 watts to 35,000 watts, in all standard voltages, frequencies and phases. Direct current models in standard voltages are described in ranges from 750 to 15,000 watts.

The 1950 Onan diesel folder is a four-page, 2-color bulletin describing the company's entire line of diesel-driven electric generating plants. Models range from single-cylinder, 2500-watt air-cooled units to massive 6-cylinder 60,000-watt water-cooled plants powered by International Harvester diesel engines.

(41) Rock Shield

Midwestern Engine and Equipment Company, Inc., 105 North Boulder Street, Tulsa, Oklahoma, has issued a bulletin on the Kapco rock shield, a product for protecting line pipe and coating. The shield is made of mastic composition board and, when secured about the pipe, gives protection in rocky areas, eliminating the need for dirt padding in the ditch. It also protects pipe and coating when making river, railroad, and highway crossings.

(42) Torque Converters

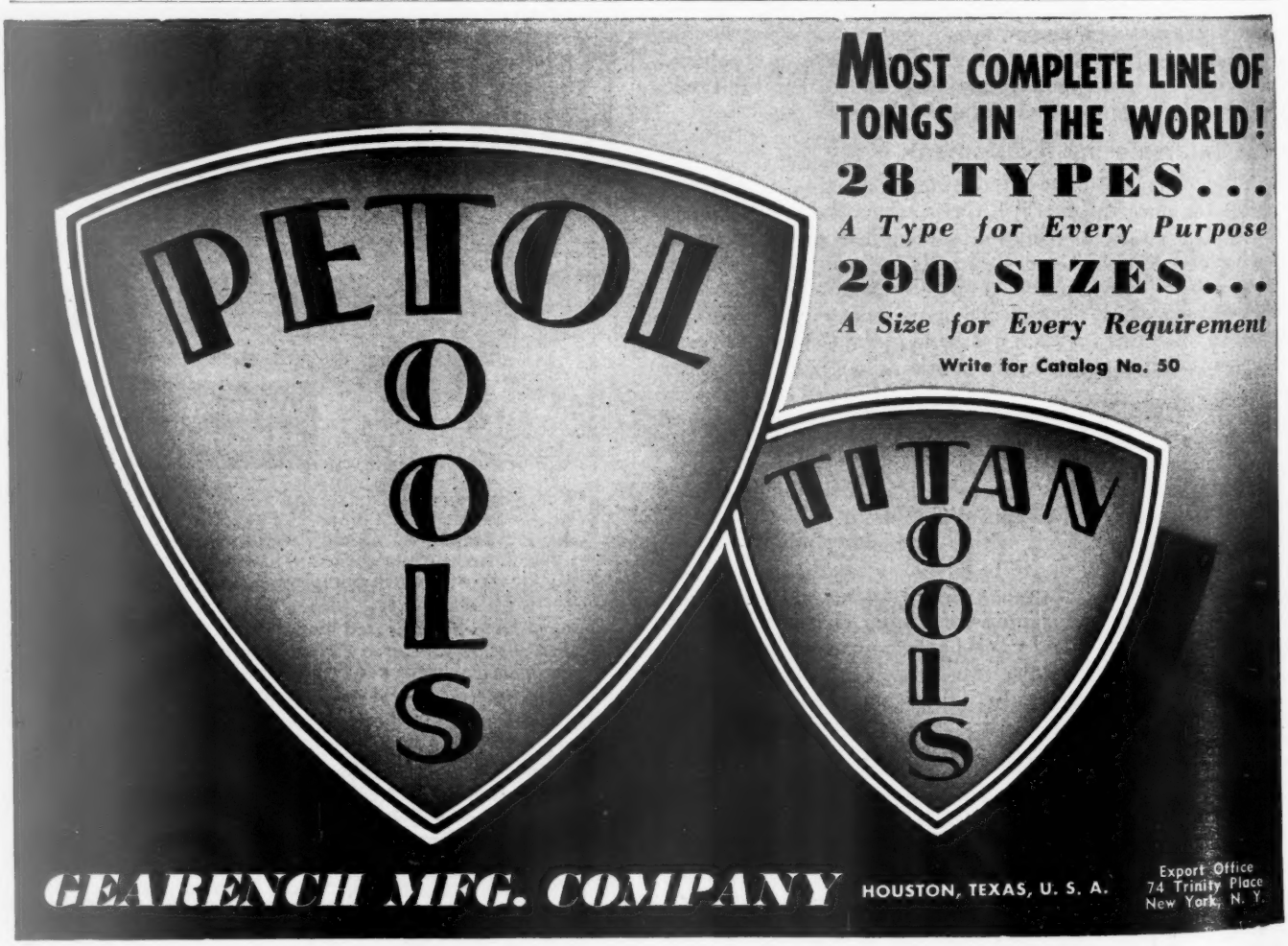
General Motors Corporation, Detroit diesel engine division, 13400 West Outer Drive, Detroit 28, Michigan, has published a new 24-page booklet on torque converters. In an effort to publicize the availability of the diesel engine—torque converter applications, the Detroit division of General Motors has published this book giving information concerning what a torque converter is and how it functions.

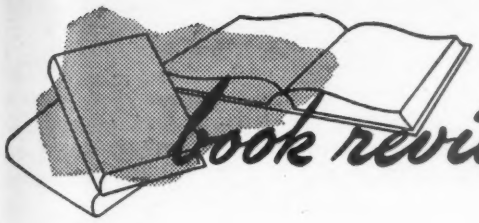
(43) Sewage, Trash Pump

Fairbanks, Morse and Company, 600 South Michigan Avenue, Chicago, Illinois has announced publication of a 16-page bulletin on its new sewage and trash pump. The pump incorporates a new feature, namely, a bladeless impeller. The bulletin fully describes the new pump, which was announced by Fairbanks, Morse in November, 1949.

(44) Sheet Packing

Various types of sheet packing it manufactures for handling liquids, gases, and abrasives has been issued by The B. F. Goodrich Company, Akron, Ohio and is available upon request. The publication lists specifications and outlines uses of the different kinds of packing and describes materials used in their construction.





Engineers' Dictionary, Spanish-English and English-Spanish, *by Louis A. Robb, John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages, 664. Price, $12.50.*

On publication of the first edition of the Engineer's Dictionary, the author began his second, more complete and more comprehensive dictionary. Though some references are made to chemistry, geology, or metallurgy, the subject is engineering, and other terms and sciences included are those that are regularly needed in connection with engineering work. The enlarged edition covers electrical and mechanical engineering more thoroughly, the author states, and radio and television terms are included. Definitions are included only in default of a satisfactory equivalent or to avoid ambiguity.

Boron Trifluoride and Its Derivatives, *by Harold Simmons Booth and Donald Ray Martin, John Wiley and Sons, Inc., 440 Fourth Avenue, New York, New York. Pages, 315. Price, $5.*

This book has been prepared by the authors to facilitate investigations made with boron trifluoride, knowledge of which has had rapid expansion in the last year or so. The material, the authors state, has particular value for research chemists in the petroleum industry, the plastics and polymer industry, for organic chemists interested in condensation and polymerization reactions in which boron trifluoride is used as a catalyst, and for chemists in the electroplating industry, the steel industry, and ceramics. Also included is bibliography including references to many articles containing information on boron trifluoride.

Quarterly of the Colorado School of Mines, *edited by Harry M. Crain, Department of Publications, Colorado School of Mines, Golden, Colorado. Pages, 162. Price, $2.*

Publication of "Petroleum Refining" as Vol. 45, No. 2A, of the quarterly of the School of Mines, is a number of the 75th anniversary volume entitled "Mineral Resources in World Affairs", which will make available all of the papers presented and much of the discussion at the conferences.

The current issue contains the papers delivered at the Conference on Petroleum Refining September 30 and October 1, 1949. Included are papers by Edward W. Isom, vice president, Sinclair Refining Company; Harrison L. Hays, superintendent of operations, and Edward Dolezal, mechanical consultant, Phillips Chemical Company; and C. K. Viland, general supervisor, research and development department, Tide Water Associated Oil Company, and many other well known men in the industry.

The Varnished Insulations Story, *by David O. Woodbury. The Varnished Fabric and Paper Section, National Electrical Manufacturers Association, 155 East 44th Street, New York 17, New York. Pages, 88. Price, $1.*

This booklet is designed to serve as an authoritative reference book on varnished insulations. Sources for the material were the major varnished insulation manufacturers. The book covers the nature and purpose of varnished insulations, their origin and development, and their use in rotating apparatus, transformers, cables, power distribution systems, motor controllers, high-tension magnetos, and electronic equipment.

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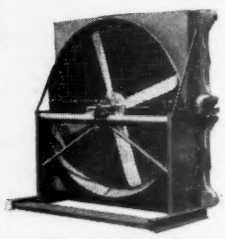

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Stainless Steels, *by Carl A. Zapffe, The American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio. Pages, 368. Price, $5.*

The author, who is a consulting metallurgist in Baltimore, Maryland, has taken up the seven chapters of the group, in defining stainless steel for the layman and the technical man alike. To comprehend the book, the reader must have only a smattering of metallurgy, and with no background can still understand and gain some knowledge on the chapters dealing with the physical and mechanical properties and general instructions for fabricating. Two chapters are written for the more technically trained reader who can go further to gain fundamental chemical and metallurgical understanding of these fields, which will fit him for a broad understanding of the whole field.

Oil and Petroleum Year Book, 1949, *compiled and published by Walter E. Skinner, 20 Copthall Avenue, London. E. C. 2. Pages, 252. Price, $4, post free abroad.*

This edition, the 40th, contains complete and up-to-date particulars concerning 733 companies operating in all parts of the world and covering all branches of the oil industry. American and foreign companies are fully dealt with. The particulars of each company, names of directors and other officials, description of business, where operating, crude oil production, refinery runs, details of capital, dividends and financial results are included. Other features are, the names and addresses of 426 managers and engineers and the names of the companies in the book with which they are connected, and the Buyers' Guide of Manufacturers of oil field and refinery equipment comprising 684 headings. Copies may be obtained from the author.

The Mines Magazine, Fourteenth Annual Petroleum Number, *Colorado School of Mines Alumni Association, Inc., 734 Cooper Building, Denver, Colorado. Pages, 128. Price, $1.50.*

This fourteenth annual edition, dedicated to petroleum, features an article on technology and the oil industry, Saudi Arabian oil fields and pipe lines, diamond drilling in oil industry, Venezuela refining program, geological engineering, Colorado "Mines", geophysical interpretation and geology, and Venezuela personnel training. It also features articles on our undiscovered petroleum reserves, reviews the Canadian oil fields, and other subjects peculiar to the oil industry.

Sixth Annual Rocky Mountain Petroleum Directory, *compiled by the editors of the* Oil Reporter, *Henry W. Hough, Editor, Petroleum Publishers, Inc., 712 Cooper Building, Denver, Colorado. Pages, 69. Price, $2.*

This sixth annual edition of the Rocky Mountain Directory carries listings of oil operators, drilling contractors, pipe line companies, refineries, gas companies, geologists, engineers, geophysical contractors, shale oil organizations, lease brokers, and suppliers. Also included is a map showing the oil and gas fields of Western Canada.

Principles and Practice of Flow Meter Engineering, *by L. K. Spink, The Foxboro Company, Foxboro, Massachusetts. Pages, 416. Price, $7.*

This handbook has just appeared in an enlarged edition, the seventh since the book was first published in 1930. The book contains information for calculating an orifice, flow nozzle, Venturi tube, Pitot tube, and a pipe elbow used for flow measurement. Added to this new handbook is a new section devoted to R. L. Parshall inventor of the Parshall Flume, giving design details, operating instructions, and tables for measuring flows through open channels by means of weirs and flumes. A detailed description of the contents of the book is given in the 8-page index.